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WPI RoboEthics Symposium: Ethics for Robotics in Our Changing World

An Interactive Qualifying Project Report

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by

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1. Robots
2. RoboEthics
3. Ethics
4. Conference
5. Symposium
6. Military

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ABSTRACT

With the advent, growth and development of the robotics industry also comes a variety of ethical issues. The modern engineer needs to be aware of these issues and to be able to act accordingly. The purpose of this project is to create a sustainable forum for discussion of ethical topics surrounding the use of robotics in our modern world. This conference brings together students, professionals, and members of academia and is called the WPI RoboEthics Symposium. The event consists of lectures from prominent industry professionals as well as debate sessions among participants. Documentation on the planning process for the event has been created to aid future WPI students in the planning of subsequent WPI RoboEthics Symposia.

INTRODUCTION

The main goal of our IQP was to hold a symposium event directly focused on the ethics of all fields of robotics. Through holding such an event the hope was to expand the general knowledge and importance of ethics in robotics. The report that follows summarizes the group's approach to organizing the symposium.

THE GROWING ROBOTICS INDUSTRY

The expanding robotics industry has many facets, such as military, industrial, medical, and also domestic applications. The latest generations of robots are cheaper, more efficient, and more versatile than ever before[1] and each of these genres of robotics poses its own unique ethical challenges. As the industry continues its upward trend of growth, these ethical issues will only continue to expand and so something needs to be done to curtail the questions and to help engineers start looking for answers.

MILITARY

The industry of military robotics is growing rapidly. There are many robotic systems already in use by the United States military to protect our freedom. Some systems are used in surveillance, such as the MQ-1 Predator made by General Atomic Aeronautical Systems, which can not only provide long range, unmanned reconnaissance, but it can also engage targets with hellfire missiles. Others such as the Foster Miller TALON robots, and iRobot's Packbot, can be used in situations deemed too dangerous for human soldiers, such as bomb disposal and room breaching reconnaissance. Foster Miller has also updated the TALON with the ability to operate a multitude of infantry weapons, such as the M249 Squad Automatic Weapon and the M82 long range .50 caliber sniper rifle.

INDUSTRIAL

Industrial robots are a topic of great argument as to whether they are helping create jobs, or replacing human workers. On one hand, they are far more efficient than an all

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[1] "Robotic Industry Hypes Drive to Market", October 20, 2009< http://news.cnet.com/Robotics-industry-hypes-drive-to-market/2100-1022_3-5702377.html>

human workforce, and thus they make much more sense for a company to implement as opposed to hiring more employees. However, these robots require someone to operate them, as well as routine maintenance. There are a number of companies that produce industrial robots such as KUKA, ABT, and FANUC. The industrial robotics market is projected to reach $17.1 billion by 2010.[2]

MEDICAL

The applications of robots to medical procedures are also rapidly growing. The most popular robotic surgeon at the moment is the Da Vinci Surgical System by Intuitive Surgical. The Da Vinci is capable of doing things a human surgeon could never do. It features three “hands” which can hold any tool the surgeon might use, perfectly still, unlike the average human. There are also therapeutic robots, such as PARO, an artificial baby harp seal, which is used in “animal-assisted therapy.” PARO uses a variety of sensors to react to its environment, such as learning a name and displaying emotion based on how it is treated by people. The medical robotics industry is predicted to reach $2.8 billion by 2011.[3]

DOMESTIC

Robots are making more and more appearances around the house in this day and age. The ubiquitous Roomba, iRobot’s automated vacuum cleaner, is becoming a household name for its ease of use and effectiveness. iRobot also makes the Looge robot which cleans gutters by driving along inside them with a spinning brush, which is not only safer, but also quicker than the traditional method of standing on a ladder and stretching. There are also robots related to things other than chores, such as the now discontinued Sony Aibo robotic dog which aimed to emulate the behavior of a puppy, without the mess. The Aibo was very popular with people living in places that did not

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[2] Kumar “Industrial Robots, Service Robots, and Personal Robots” October 20, 2009 <http://www.wtec.org/robotics/workshop/PDF/05-IndustrialPersonal-Kumar-eBook.pdf>

[3] “Medical Robotics and Computer-Assisted Surgery” October 20, 2009 <http://www.marketresearch.com/product/display.asp?productid=1331799>

allow pets such as apartments and dormitories. A new study by ABI Research predicts that the personal robotics market will be worth $15 billion by 2015.[4]

ETHICS IN GENERAL AND WHY ENGINEERS NEED ETHICS

Ethics is the study of the characteristics of morals, and involves the choices made by individuals as they interact with others. Not just in engineering, but in every major piece of society, ethics plays a major role. Everyday people have to make many ethical decisions about their lifestyle, their interactions, and their plans.

Engineers need to be aware of ethics as they make choices during their professional practice of engineering. It is important for engineering students to study engineering ethics so that they are prepared to make ethical decisions during their careers. Ethics is a very important aspect to an engineer's career. Whether working for a major company, or spawning a new company from an idea, it is important to consider the ethics of what the engineer does from day to day. When working on a project, an engineer has to consider whether or not one is being socially responsible by creating a product, or making technological advances to an existing product.

- Many case studies in engineering ethics do not have a single correct answer, but may have many correct solutions, depending on an opinion. Ethical problems can be similar to open-ended engineering design problems, where multiple solutions can exist.
- Work requires sophisticated skills, judgment, and exercise of discretion
- Membership in the profession requires formal education
- Special societies establish standards for admission into the profession and conduct of its members
- Significant positive public service results from the practice of the profession

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[4] "Personal Robot industry to grow to $15 billion by 2015", October 20, 2009 <http://www.gizmag.com/personal-robot-industry-to-grow-to-15-billion/8569/>

Codes of ethics have been established by various professional engineering societies, such as the National Society of Professional Engineers (NSPE), the American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers (IEEE), etc. These codes serve as a structure for ethical judgment for a professional engineer. The codes of ethics are not comprehensive enough to cover all possible ethical dilemmas that an engineer might encounter in his or her career.

- Engineers shall hold paramount the safety, health and welfare of the public
- Engineers shall perform services only in areas of their competence
- Engineers shall issue public statements only in an objective and truthful manner
- Engineers shall act for each employer or client as faithful agents or trustees
- Engineers shall avoid deceptive acts
- Engineers shall conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by using their knowledge and skill for the enhancement of human welfare, being honest and impartial, and serving with fidelity the public, their employers and clients and striving to increase the competence and prestige of the engineering profession.[5]

Ethics is discussed when engineering failures occur. Two examples are the Ford Pinto exploding gas tanks and Kansas City Hyatt Regency walkway collapse.

The cases involving the explosion of Ford Pinto's due to a defective fuel system design led to many issues, most centering around the use by Ford of a cost-benefit analysis and the ethics surrounding its decision. Although Ford had access to a new design which would decrease the possibility of the Ford Pinto from exploding, the company

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[5] Wikipedia, “Engineering Ethics”, October 16, 2009, <http://en.wikipedia.org/wiki/Engineering_ethics>

chose not to implement the design. The company defended itself on the grounds that it used the accepted risk/benefit analysis to determine if the monetary costs of making the change were greater than the societal benefit. The risk/benefit analysis requires an examination of the costs, risks, and benefits through use of the product as a whole. Based on this analysis, Ford legally chose not to make the design changes which would have made the Pinto safer. Even though it was legal doesn't mean that it was ethical. It seems unethical to determine that people should be allowed to die or be seriously injured because it would cost too much to prevent it.[6]

The case involving the collapse of the Kansas City, Missouri Hyatt Regency Hotel Walkways was the most devastating structural failure, in terms of loss of life and injuries in the United States. It left 114 people dead and over 200 others injured. Millions of dollars in costs resulted from the collapse, and thousands of lives were adversely affected, all because of disputed conversations between an engineering design firm and a fabricator, and negligence on the part of the contracting engineering firm. This example shows a great example of negligence of ethics and that the importance of accuracy and detail in engineering design is very serious.[7]

ROBOTICS ENGINEERS & ETHICS

Robotics engineers have to be involved with more ethical issues than perhaps any other field of engineering. Robotics is evolving at such a rapid pace, that major ethical decisions need to be made, and made correctly, constantly, in order to keep the development of such a vast technology on the right track. If a robotics engineer chooses to ignore the ethics behind what he/she is developing, it could start a snowball effect leading to other poorly made ethical decisions.

At Georgia Institute of Technology a robotics engineer has been working to design software that creates “ethical robots.” How can a robot be ethical? How do we know it will make the right decisions? The plan is to have these robots designed with a so-

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[6] Paul, Christopher, “Case Study #2: The Ford Pinto”, <http://userpages.umbc.edu/~cpaul1/theintegralworm/EthicalPaper_2.htm>

[7] Wikipedia, “Hyatt Regency walkway collapse”, September 25, 2009, <http://en.wikipedia.org/wiki/Hyatt_Regency_walkway_collapse>

called "guilt system" that will determine and innocent human from a soldier. Since the military is asking for more robots the goal is to embed these robots with laws of war and rules of engagement. It is very important for robotics engineers to be aware of all the worse case scenarios and to design a way to prevent them and be ethical.[8]

WPI'S SOCIAL RESPONSIBILITY

"A robotics revolution is underway, and a new breed of engineer will be needed to face the challenges it represents." [9] WPI prides itself on creating a "new breed of engineer" through its newest interdisciplinary undergraduate Robotics degree program. This new breed of engineer is not only academically interdisciplinary but is also socially conscious—and recognizes the effect that he or she has on the world in which they live.

As an institution for higher education that is emphasizing the development and advancement of robotic technologies, WPI has a social responsibility to educate its new breed of engineers on the ethical considerations that arise with promotion of these new advancements.

PROJECT SCOPE

The purpose of this IQP is, primarily, to raise awareness of the ethical issues surrounding decisions that modern robotics engineer must face. Our purpose is not to provide a single end-all answer to ethical issues that surround the development of robotic systems, but rather, to make engineers aware that the things that they do to advance the field of robotics have far reaching repercussions, and affect more than themselves and their immediate community. This project aims to accomplish this task by creating a sustainable and interactive forum for the exchange of ideas on these issues. This forum will be called the WPI RoboEthics Symposium.

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[8] Kerr, Dara, "Robotics Engineer aims to give robots a humane touch", July 8, 2009, <http://news.cnet.com/8301-11386_3-10281328-76.html>
[9] WPI Robotics Department Website

MOTIVATION

When the group members first started this IQP, research was conducted on the ethics of robotics in our society. Books and articles were read, that were already published on the subject. Interviewing prominent people in the industry was on the to-do list. A couple members attended a robotics convention. The original plan was to write a research paper taking what they had read about and learned, and putting it all together.

It was decided that the second part of the paper would cover where robotics could be going and how it would affect the rest of society. Soon after the initial research began a major flaw was realized in the plan. There was an extreme lack of information out there on the subject. The information that was out there was hidden in pages and pages of text, or in small speeches given at conferences and conventions. Additionally, ethical issues regarding robotics research are not solely confined to military applications. The effects of robotic development are far reaching and encompass every aspect of life in which robotic solutions can be used.

The group determined that a compromise for the project was needed. The solution was to hold a symposium, directly targeted at the ethics of robotics in a rapidly changing society. This would create a great forum for speakers to talk about their research, and students and professionals alike, to debate and discuss that which is becoming ever more prevalent in this modern age. This option was an especially good fit because of the numerous other robotics/ethics related IQPs currently taking place at WPI as well.

BACKGROUND RESEARCH

Basic research was conducted on the topics of conferences and symposia in general. It was noted that there were some events that took into account ethical issues surrounding the implementation of robotic technologies, however very few had a primary focus being the ethical issues surrounding the robotic development in modern society.

One conference that is held annually in different locations around the world, called RoboEthics touches on many similar and different topics than our symposium.

RoboEthics focuses primarily on creating a framework for taking care of ethical implications of robotics research. Although RoboEthics promotes discussion about the topic in their workshops, speeches, and meetings, they do not involve a key voice in the decisions involving the future of robotics; the voice of the upcoming generation of engineers. It is key for current engineering students to be able to voice their opinion on where the development of robotic technology is going in this ever-changing society.

Another recently held conference is called International Conference Social Robotics (ICSR 2009), held this past August in Incheon, Korea. The goal of this conference was to bring together researchers and practitioners from many different disciplines to discuss the social implications of robots being able to interact among themselves, with humans, and other species. Again, they failed to cover a key aspect of the issue, involving up and coming engineers. Only older professionals were invited to participate. This conference also did not focus, at all, on the ethical implications of military robotics.

TABLE 1: ROBOTICS CONFERENCES WITH ETHICAL TOPICS

Title	Main Topic	Location	Primary Sponsor	Frequency
RoboEthics[10]	Cross-cultural debate on development of roboethics	Worldwide	IEEE	Annual
ICSR 2009[11]	Cross-discipline interaction on social robotic implications	Incheon, Korea	FIRA and Incheon Metropolitan City	to be annual
APPE 2009[12] **Meeting**	Discussions and speeches on ethics in general, including military, and engineering ethics.	Cincinnati, Ohio	Association for Practical and Professional Ethics (APPE)	Annual
7th Int'l Conference on Field and Service Robotics[13]	Encouraging the development of field and service robotics.	Cambridge, MA	International Foundation of Robotics Research	Annual
Ethicomp 2008[14]	Robot ethics, hacking, and DNA databases	Italy		Annual

In fact, the issue of robotic ethics is such a current issue, that IEEE has a whole committee focused on the subject. The committee constantly is doing research and other activities, exploring robotic ethics and related fields. The IEEE magazine is having a special issue in March of 2011 titled RoboEthics. This issue will feature several guest editors very experienced in the ethics of robotics.[15]

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[10] "RoboEthics", Oct. 19, 2009, < http://www.roboethics.org/>
[11] "CFP: FIRA International Conference Social Robotics (ICSR 2009)", Dec. 8, 2008, http://www.bartneck.de/2008/12/08/cfp-fira-international-conference-social-robotics-icsr-2009/>
[12] "Association for Practical and Professional Ethics", Oct, 2009, <http://www.indiana.edu/~appe/annualmeeting.html >
[13] "The 7th International Conference on Field and Service Robotics", July, 2009, <http://www.rec.ri.cmu.edu/fsr09/ >
[14] "Computer Ethics Debated At Major Conference", Sept 18, 2008, <http://www.highbeam.com/doc/1G1-185258840.html>
[15] "IEEE Robotics & Automation Society" <http://www.ieee-ras.org/ram/special_issues>

UNIQUE SYMPOSIUM STRUCTURE

After conducting the aforementioned research on the subject of academic symposia, it was decided that this conference should be different. In keeping with the WPI tradition of pioneering methodologies, it was determined that the WPI RoboEthics Symposium should feature not only the standard keynote speakers, lecturers and presenters that every other symposium has, but that it should be an interactive event—a dialogue between robot enthusiasts, engineers, students and industry professionals.

While it is beneficial to listen to what others have to say on a subject, the best way to fully understand a topic is to become involved in dynamic discussion on a subject. When group members are allowed to voice their individual viewpoints in a collaborative environment, everyone learns. One of the major objectives for this symposium is to create a forum for the active exchange of information and viewpoints on the topics of robotics ethics rather than to passively listen to the viewpoints of a few lecturers and keynote speakers.

To accomplish this exchange of information, two unique aspects have been integrated into to the symposium: the addition of students into the attending group and a series of moderated discussion sessions that follow keynote speakers and lecturers.

The incorporation of these two unique program aspects will ensure that there is real, true dialogue, and back and forth of ideas between not only professionals, philosophers and researchers, but between the students that are studying these critical issues and will be entering the workforce and institutes of higher education and will have to deal with ethical issues on an everyday basis.

PROPOSED EVENT LOGISTICS

WPI ROBOTICS ENGINEERING PROGRAM SUPPORT

Support from WPI Robotics Engineering Program was sought in an effort to make the event more academically legitimate and to seek financial backing for the event. A presentation was prepared and presented to the program administrators and faculty. The primary focus of the presentation was to express the need for an event such as the WPI RoboEthics Symposium as well as WPI's social responsibility to host such an event.

During the course of the presentation, there was concern that the event would not be unique in comparison to other robotic symposia and conferences. The IQP team explained that the event was, in fact, different from other events, specifically because part of its target audience was college students and because it would feature an interactive moderated debate session. After hearing this argument, the consensus was that the event was unique enough, and that WPI would host its own RoboEthics Symposium.

One of the major suggestions offered during the presentation for the execution of the symposium was to not be too specific or favor one aspect of robotic ethical issues over another. The example they provided was the discussion of ethical issues surrounding the use of robots in the military. Those in attendance warned that it might be easy to get skewed towards one ethical aspect over another and that the symposium would be better off if it was ensured that there was equal consideration given to all aspects.

The presentation given during this session can be found in Appendix A.

EVENT OVERVIEW

This 2010 WPI RoboEthics Symposium will be the first of a series of annual events designed to foster discussion on ethical issues that surround the development of advanced robotic systems. This single-day event will be held on April 10, 2010 on the

third floor of the WPI Campus Center. The program will consist of keynote speakers, lecturers and moderated ethical debate sessions.

The tentative proposed schedule can be seen in the table below:

TABLE 2: PROPOSED SYMPOSIUM SCHEDULE

Time	Activity
8:15:00	**Event Begins**
9:00:00	Registration Opens
	Breakfast Served
	Introduction
10min	WPI IQP Intro
10min	WPI Speaker
10min	WPI RBE Department
9:30-10:30	**Keynote #1**
10:30-10:40	Transition Time
10:40-11:40	Session 1
11:40-11:50	Transition Time
11:50-12:50	Session #2
12:50:00	**Lunch Served**
1:10-2:00	**Keynote #2**
2:00-2:10	Transition Time
2:10-3:10	Debate Session 1
3:10-3:20	Transition Time
3:20-4:20	Debate Session 2
4:20-4:45	**Closing Remarks**

EVENT FINANCES

COSTS

The primary costs associated with this event will include transportation for speakers and lecturers that are not local to the event location, print materials, as well as food for participants.

FUNDING SOURCES

It was determined that due to the nature of the symposium; it would be sponsored by the WPI Robotics Engineering Program as opposed to an outside corporate sponsor. Associating a "RoboEthics Symposium" with a specific corporation might give the impression that the viewpoints presented in the symposium might be skewed to benefit the sponsoring company.

Because the targeted audience for this event includes college students (who are oftentimes short on money) it was also determined that in order to encourage participation, there would be no event fees associated with attending this event. The option to purchase booth style advertising space will however be presented to participating individuals and companies similar to the system used by other conferences and symposia.

TENTATIVE BUDGET

Below is an estimated expense sheet outlining the major costs of the event. For purposes of mean cost calculation, numbers are based on a total of 150 attendees. The excel document form of this table can be found in the Appendix I.

TABLE 3: ESTIMATED EXPENSE SHEET

Estimated Symposium Expenses				
		Price	Quantity	Subtotal
Food				
	The Head Start Breakfast	$6.50	150	($975.00)
	Joe's Famous Trayed Sandwiches	$7.75	150	($1,162.50)
Marketing				
	Posters	$2.00	15	($30.00)
	Programs	$5.00	150	($750.00)
	Invitations	$3.00	100	($300.00)
Speakers				
	Hotel	$150.00	3	($450.00)
	Transportation	$60.00	3	($180.00)
	Flight	$300.00	3	($900.00)
Income				
	Table Sponsor	$250.00	5	$1,250.00
	Speaker Reimbursement	$400.00	3	$1,200.00
				($2,297.50)

VENUE

The 3rd floor of the WPI Campus Center was chosen as the venue for this robotics event, primary because of its unique and versatile selection of rooms. The three Odeum rooms will be useful for the keynote speaker sessions as well as the introductory and concluding remarks in addition to networking and eating time.

The numerous conference rooms that the center provides will also be useful for the debate sessions and smaller lectures that will be held as well.

EVENT MARKETING

Initial ideas for marketing were brainstormed by the group however after doing research on school policies, it was discovered that the WPI marketing department was available as a resource to help make a comprehensive and cohesive scheme for print and marketing materials. Collaboration with the marketing department will continue to take place while they develop the materials for this event.

Targeted Audiences

The primary targeted audience for this event consists of college students, industry professionals, philosophers, science fiction writers, robot hobbyists, and members of academia including faculty and staff. The purpose of this event is to foster cross-group and cross-disciplinary communication on these topics so in reality, anyone who has an interest in robotics and how it will affect our society is encouraged to be a part of this event.

Website

An initial draft for the symposium website was created to aid the WPI web developers in the design of the symposium website. The symposium website will be the primary resources for those attending the event. The website draft is based on the below template called "dragonfly" from a free web template site. The site contains the following information about the symposium under the enumerated page titles and a screen shot of the template used can be seen in the figure below.

1. Home
    a. As the pioneer for undergraduate robotics WPI recognizes that there are ethical issues that are raised in our society by facilitating the advancement of robotic development. The purpose of this symposium is to raise awareness of the ethical issues surrounding the use of robots in society by providing an interactive forum for technical and non technical discussion and networking between students and industry professionals.
    b. Quote: "With great power there must also come....great responsibility." (Stan Lee, Creator of the 'Spiderman' Comic Series)
    c. WPI has recognized the social responsibilities associated with being a pioneer in an emerging industry and as a result, is taking steps to ensure that future generations of engineers and scientists are aware of the impact that their actions cause on society.
2. Program & Speaker Information

   a. See Table 2 for program information
   b. Speaker Information TBD
3. Venue
   a. This event will take place on the second floor of the WPI Campus Center**.**
   b. Founded in Worcester, Mass., in 1865, WPI was one of the nation's earliest technological universities. From our founding days, we've taken a unique approach to science and technology education.
   c. Parking Information: The Higgins House and Quad parking areas have been reserved for this event.
   d. Links to Useful Information

      i. WPI
      ii. About WPI
      iii. WPI Undergraduate Robotics
      iv. Directions
      v. Lodging Information
      vi. Campus Map
      vii. Campus Phone Numbers
4. Debate
   a. This second portion of the WPI RoboEthics Symposium will consist of a series of debate sessions on topics pertaining to ethical issues surrounding the use of robotics in various applications. The purpose of these debates is to stimulate awareness and thought on ethical issues pertinent to those involved in this new "robotics revolution" and to facilitate discussion between professionals and students in the robotics industry. These debates will be moderated and will be conducted in "round table" setting and all participants are invited and encouraged to participate. A list of sample discussion topics and directions to submit your own topics can be seen below.
   b. Sample Debate Topics TBD
5. Registration
   a. A Google Form will be embedded into the website for event registration.
6. WPI
   a. Link to the WPI Website
7. Contact Information

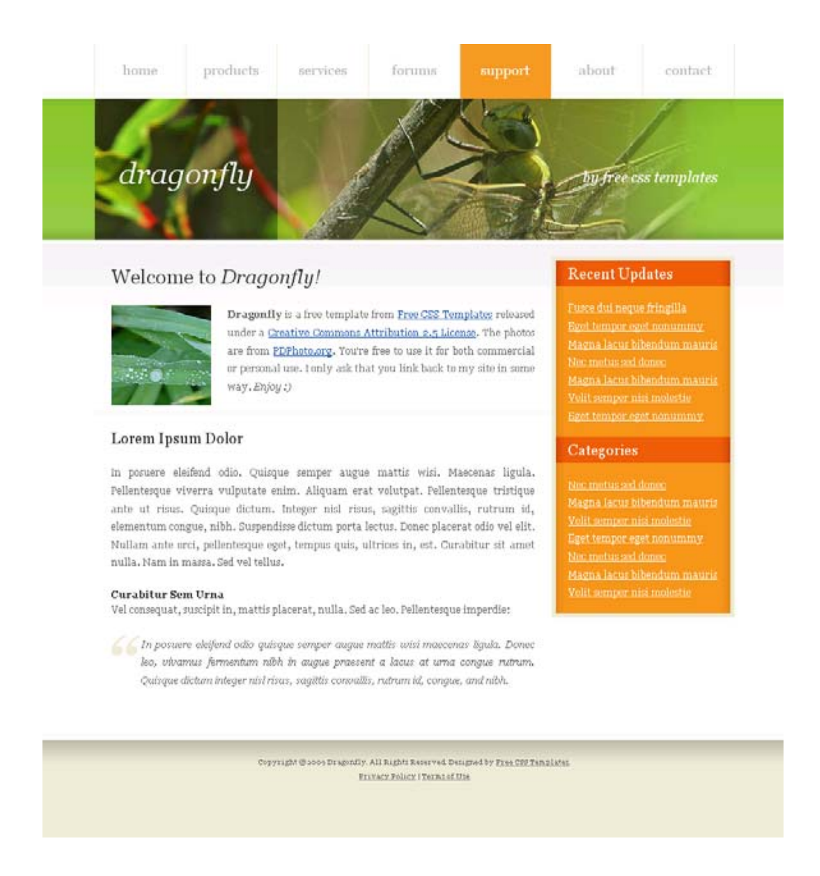


FIGURE 1: SYMPOSIUM WEBSITE TEMPLATE[16]

INVITATION

A formal, paper invitation will be sent out to universities and businesses about a month prior to the event. Because the primary form of communication for event proceedings will be via web and email, this is a formal gesture to those guests who require formal dealings such as university personnel and business professionals.

REGISTRATION FOLDER

A registration folder that contains information about the symposium will be provided to all attendees upon registration. This folder will be designed by the WPI Marketing department with its content provided by the IQP group.

FOOD

From prior experience attending symposia and other academic conferences, it was known that food is generally provided at events such as the WPI RoboEthics

[16] "Free CSS Templates .org", October 01, 2009. <http://www.freecsstemplates.org>

Symposium. WPI's numerous other conferences such as the Neuroprosthesis Symposium provided food for its participants so it was determined that because of this precedence, Breakfast and lunch shall be provided at the event at the expense of the department.

STAFFING

Volunteer Staffing for the event will be provided by WPI Robotics Majors. Various volunteer staff positions will include:

- **Event Setup/Takedown Staff:** These students will assist the IQP team in setting up and cleaning up after the event and ensuring that all venue requirements are met.
- **Registration Table Staff**: These volunteers will be responsible for checking in symposium guests and ensuring that all of their needs are met. During the symposium proceedings this table will remain open as an "information" desk for guests who have questions or other needs.
- **Audio/Video Documenters**: for Debates and Lectures
- **Debate Session Moderators**: These volunteers will be responsible for ensuring that debate sessions Debate moderators will undergo some kind of informational training session to ensure that they know how to professionally and effectively moderate debate sessions.

In accordance with WPI event requirements, a police officer and custodian paid for by the program and provided by the school will also be working the event.

RESULTS

The WPI RoboEthics Symposium was held on April 10th in the Odeum of the WPI Campus Center. The event overall, was a success, and those in attendance had the opportunity of not only listening to the research being done by two renowned speakers in the area of robotics and our own WPI student IQP group who have been working together to put together a code of ethics for robotic engineers, but also had the opportunity to participate in debate sessions with their peers. The day definitely succeeded in its purpose of providing an interactive forum for discussion of the topics of robotics, ethics and the effect that robots have on society.

A total of just over 50 people attended the event. Of those that registered, over half were WPI students, and roughly a quarter were WPI faculty and staff members. The other participants were from companies such as iRobot, Autonomous Exploration Inc, ProGen, and QinetiQ as well as friends and family members of those that were presenting and running the event.

EVENT SCHEDULING

When it was confirmed that the event would consist of two keynote presentations and one student group presentation in addition to the debate sessions, the schedule was pushed back to accommodate the changes. It is our belief that pushing the schedule back and shortening the overall length of the conference had a positive effect on conference attendance. The purpose of the symposium is to bring together many different types of people-students, members of academia, business professionals, philosophers, writers-groups that potentially include people who might not be used to the idea of giving up a full Saturday to attend an academic conference.

NATIONAL ROBOTICS WEEK

The timing of the WPI RoboEthics Symposium was planned to coincide with the "National Robotics Week." The purpose of this week is to accomplish the following:

- “Celebrate the US as a leader in robotics technology development
- Educate the public about how robotics technology impacts society, both now and in the future
- Advocate for increased funding for robotics technology research and development
- Inspire students of all ages to pursue careers in robotics and other Science, Technology, Engineering, and Math-related fields”[17]

This being their first year holding this week long event, they were eager to find more nation wide participants to add to their schedule. We as a team gladly agreed to hold the symposium as part of “National Robotics Week.”

EVENT KEYNOTE SPEAKERS

A variety of leaders in the area of Robotics and Ethics were sought to speak at the event. Initial invitation emails were sent to potential candidates that outlined the purpose and logistics of the event and asked if they would be willing to share their research in the area of robotics ethics at the symposium. The two speakers that responded saying that they would be able to attend were Ronald Arkin from Georgia Institute of Technology and Noel Sharkey of the University of Sheffield in the United Kingdom. Arranging details for their visit to WPI was no simple task, and a lot was learned about the ways in which speakers, in general, expect to be treated when they are brought in to speak at an academic conference. Experienced gained from this interaction were invaluable and will definitely serve the group members in the future when it comes to arranging events of this kind. It was expected that travel be totally arranged by our group and frequently checked that their travel was being taken care of. Additionally, they expected a full itinerary outlining the details of their trip and during the exchange of emails hinted that a contact point should be made for them at the event. The itineraries for the speakers can be found in the Appendix P. Their hinting led to a

[17] National Robotics week. (n.d.). Retrieved 03 15, 2010, from <http://www.nationalroboticsweek.org>

student “escort” being appointed who would ensure that everything went smoothly for them at the event. A few days before the event, it was suggested that the department head and members of the WPI Robotics faculty meet with the speakers for breakfast the morning of the event to discuss the WPI Robotics Program as well as the speakers' backgrounds and research interests. This breakfast was arranged. Arrangements fro a speakers' honorarium were made by providing the speakers with a form that they filled out that later was set to the CS department for processing. The honorarium form can be found in the Appendix P.

In his presentation, Ron Arkin discussed many ethical issues that he experienced during his ongoing work with the Military. These included both robotic issues as well as purely human problems as well. He also went on to explain his ideas for how a system could be implemented to fight a more ethical battle either with a fully robotic force, or one comprised of both humans and their autonomous assistants.

Noel Sharkey spoke about a broad view of how robots are being used across the world in the military, medical, personal, and many other needs. A medical robot that is being used is one that can take care of the elderly when they are in need. Many personal robots that are used across the world are robots that can take care of kids, can play with kids, can even babysit kids, and ones that people could have sexual relations with. Is this ethical?

STUDENT INTRODUCTION

The symposium opened with a statement by one of the IQP group members, Sabrina Varanelli outlining the underlying reasons behind the event, and why the event was held in general. This statement can be found in Appendix C.

ROBOTICS ENGINEERING PROGRAM DIRECTOR INTRODUCTION

The WPI Robotics Engineering Program Director Michael Gennert gave an introduction before the keynote speakers. He spoke about the WPI Robotics Engineering Program

and projects that students are currently working on. Professor Gennert also spoke on how fast the industry of robotics is growing and the need for engineers.

WPI IQP GROUP PRESENTATION

EVENT FINANCES

The WPI Robotics Department ended up providing the funding for the entire event. The scale of the event prevented the acquisition of the table sponsors that the group originally intended to aid in the funding of the event. In the future when the event is larger, efforts to obtain vendors who would be willing to pay for advertising space might be a good method for keeping the attendance costs of the event down.

>>INSERT BUDGET SPREADSHEET<<

PRINT MATERIALS

Print materials for this event were developed by both the WPI Marketing Department and Sabrina Varanelli. A collaborative effort was employed in the development of event branding and the WPI Marketing department was instrumental in helping this to occur. Logos, event posters, speakers' posters and the event program can all be found in Appendices D and H.

EVENT PROMOTION

Overall, this aspect of the event was arguably the weakest. So much time was spent getting the event together, that the promotion of the event was mainly limited to the WPI community. For future events, more notice should be given to potential attendees and more channels of communication should be used. A major source of advertisement could have been the Robotics Trends online newsletter. We were in contact with the editor of the newsletter, however were unable to coordinate with the Marketing department at WPI quickly enough to get the ad into circulation.

An email sent out earlier to the "robotics Worldwide" mailing list would also have been beneficial to overall event attendance. Primary methods of event marketing included

distribution to relevant WPI Mailing lists, and the promotion of the event in a Facebook group. Additionally, a media advisory was prepared by the WPI Media Relations office which was distributed to newspapers and local media sources in Worcester. This advisory can be found in Appendix N.

EVENT WEBSITE

The website was created by Sabrina Varanelli using Dreawmweaver and a modified CSS template according to the proposed outline. A screenshot of the home page can be seen below. Raw data files for the website can be found in Appendix G. The event URL is www.roboethics.wpi.edu. A network drive was set up on the ECE network to support the site. For more information, see the "ReadMe" file in the website folder located in Appendix G.



FIGURE 2: WPI ROBOETHICS SYMPOSIUM WEBSITE HOME PAGE

Debate Sessions

Due to the number of attendees present at the end of the symposium, the two debate sessions were condensed into a single longer session. The session was moderated by members of the WPI Debate Team, and was very engaging and well-implemented. Thos in attendance were presented with a variety of topics in the areas robotics-ethics to stimulate discussion, but was encouraged to branch off from listed topics and to discuss issues raised by the morning keynote speakers. During registration, each member in attendance was asked to sign a release form allowing the recording of the presentation. The recorded debate session can be found in Appendix L. After the raw data was gathered, members of this IQP group created a summary document. This document can be found in Appendix M.

Program Sustainability

As human understanding of how the world works increases and as our knowledge of how to create new and useful technologies develops, we are constantly faced with moral and ethical issues that arise with the creation of new ideas. Ethics of scientific development are not something to be considered once and then not thought about again. One of the major goals for this project was to create a sustainable framework for robotic ethical awareness in the WPI community through the interaction of industry professionals, students and members of academia. This goal has been fulfilled by the creation of a repository of information that will provide future IQP groups with the materials necessary to recreate and improve upon this event. All of these documents can be found in organized folders contained within Appendix P.

Conclusion

Through the group's initial research of ethics with regard to Robotics Engineering, it was found that what information did exist was often very specific and could not necessarily be applied to all robotics. Then it was proposed to host a conference to promote and discuss ethical issues pertaining to our topics which could be applied not only to Military Robotics, but Robotics Engineering as a whole. The group then asked for sponsorship

from the University since it would seem that the school would want to have a positive impact on the ethical decisions that its students will be making in the future. It is the group's hope that the transcripts from the conference's discussions and presentations will aid not only WPI students, but future and current roboticists in the many ethics decisions which await the rapidly evolving field of robotics. The event was executed successfully and much information was gleaned from this first iteration of the WPI RoboEthics Symposium. Through this group's work on this Interactive Qualifying project, a framework has been created for the successful execution of future "WPI RoboEthics Symposia" to take place. In addition to creating the framework, the inaugural event was successfully held. Based on the success of the event, and all of the information provided, it is predicted that this event should be held in years to come.

SOURCES

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APPENDICES

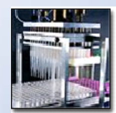
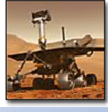
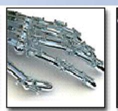
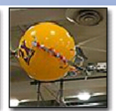
Appendix A: WPI RoboEthics Symposium Proposal to the Robotics Engineering Program
Appendix B: "Ethics of Military Robotics" Essay
Appendix C: Symposium Event Introduction
Appendix D: Event Poster
Appendix E: Keynote Speaker Biographies
Appendix F: Presentation Abstracts
Appendix G: Event Website Images
Appendix H: Event Program
Appendix I: Event Expenses
Appendix J: Debate Session Presentation
Appendix K: Debate Session Recording
Appendix L: Debate Session Summary
Appendix M: WPI Media Advisory
Appendix N: Event Photos
Appendix O: Event Planning Documentation Folder

Appendix A: WPI RoboEthics Symposium Proposal to the Robotics Program



<u>WPI Robotics Department Website:</u>

A robotics revolution is underway, and a ***new breed of engineers*** *will be needed to face the challenges that this exciting field represents.*

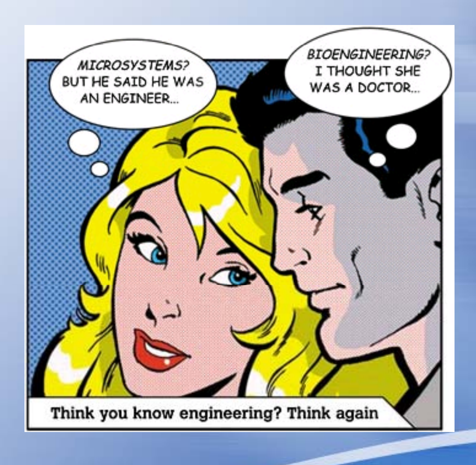
<u>Carol Simpson (Previous WPI Provost):</u>

“This [RBE] major is designed to prepare a ***new breed of engineer*** *with the skills and imagination to develop machines that go far beyond today’s reality.*



Who is this “New Breed of Engineer” ?

Academically Interdisciplinary…Socially Conscious





Project Scope

WPI is the Pioneer for Undergraduate Robotics

- WPI recognizes the ethical issues that are raised by facilitating robotic development
- Raise awareness of ethical issues surrounding the use of robots in society
  - Create a forum for technical and non technical discussion
  - Link Professionals, Students, Industry
  - Bring the issue to the forefront

“With great power, comes great responsibility.” -Spiderman



WPI Roboethics Symposium

Ethics for Robotics in our Changing World

- Single-Day "Annual" Event
  - Networking
  - Lectures
  - Debate
- Helps to bring awareness to this new and important issue
  - Other events touch on subject, none completely address topic
- IQP Scope
  - Military Robotics Root
  - Needed a forum to present idea
  - Expanded to include broader topics
- Facilitate promotion of other IQPs



Event Logistics

8:15:00	**Event Begins**
	Registration Opens
	Breakfast Served
9:00:00	**Introduction**
10min	WPI IQP Intro
10min	WPI Speaker
10min	WPI RBE Department
9:30-10:30	**Keynote #1**
10:30-10:40	Transition Time
10:40-11:40	Session 1
11:40-11:50	Transition Time
11:50-12:50	Session #2
12:50:00	**Lunch Served**
1:10-2:00	**Keynote #2**
2:00-2:10	Transition Time
2:10-3:10	Debate Session 1
3:10-3:20	Transition Time
3:20-4:20	Debate Session 2
4:20-4:45	**Closing Remarks**

Saturday
April 10, 2010

WPI Odeum &
Campus Center

Event Staff

- Debate Moderators
- Recording Crew
- Registration Table Worker
- WPI Provost/President Speaker
- WPI RBE Department Speaker

WPI

Event Marketing

- Website
- Business Outreach
- Robotics Cluster
- Advisory Board
- Personal Contacts
- Robotics Trends
- Worcester Consortium





Estimated Symposium Expenses

		Price	Quantity	Subtotal
Food				
	The Head Start Breakfast	$ 6.50	75	$ (487.50)
	Joe's Famous Trayed Sandwiches	$ 7.75	75	$ (581.25)
Marketing				
	Posters	$ 50.00	1	$ (50.00)
	Programs	$ 50.00	1	$ (50.00)
Speakers	Hotel	$ 150.00	3	$ (450.00)
	Transportation	$ 60.00	3	$ (180.00)
	Flight	$ 300.00	3	$ (900.00)
Income				
	Table Sponsor	$ 150.00	4	$ 600.00
	Speaker Reimbursement	$ 400.00	3	$ 1,200.00
	Event Fees	$ 10.00	75	$ 750.00
	Total Estimated Department Cost WITH Event Fees			**$ (148.75)**
	Total Estimated Department Cost WITH Event Fees			**$ (898.75)**



ETHICS OF MILITARY ROBOTICS

Jola Myrta

Andrew Haggerty

Alex Scott

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Appendix B: "Ethics of Military Robotics" Essay

Introduction

In these next few sections we have included the initial research for this project, such as the responsibilities of a robot, media's perception of robots, and the comparison of a videogame and war and how these ethical issues affect our society. Responsibility, this is a major ethical issue in our opinion, because as we have seen many cases of robots failing, who are we going to blame a robot, the engineer, or the operator? There is no right answer to this question. How media portrays robots is also another issue that's changed what people think about robots. As we have seen in many movies, the first thing we think is a robot kills people and takes over humans. But is this what they really do? Have we not designed robots to save human lives? Lastly we examined how war and videogames could lead into the future. How do we know a person won't turn a dangerous video game into reality, and we have seen in cases before where humans get so caught up in a game they think their life is a videogame.

Responsibility

In this section I will cover many of the issues regarding robot responsibility. This includes situations where a robot makes a possibly fatal mistake. I will analyze who takes the blame for such an event, and what the consequences could and should be.

Throughout the paper I will go into specifics on where current military robotics stands, and the current "rules" set up to govern the already existing robotic, and semi-robotic devices in the military. This in-depth view of the military robotics of today will include both weaponized and non-weaponized robots in development and currently being used

on the front lines. I will look at companies such as Foster Miller, iRobot, BAE Systems, Raytheon, and other private companies currently involved in military robotics.

I will also be analyzing opinions of many different sources. With these opinions, I will be able to fully comprehend what is currently believed to be the way to handle robot responsibility and accountability.

A major development in military robotics at the moment is Foster Miller's SWORD robot. I will look closely at how this robot is governed, and how it is currently used actively in the military. Since the development of the SWORD and its upcoming modified versions is a continuous process, it will be a good chance to see how people involved with the project, and not involved with the project, handle the moral dilemmas associated with weaponizing a robot.

Having a fully autonomous weaponized robot is always a controversial topic. I will attempt to gauge the likelihood of a weaponized robot becoming fully autonomous in the future. This opens many new doors on accountability, to the point where one could question, “Can the robot itself be blamed for its actions?”

Lastly, I will look at the consequences of robotic mistakes in the military. When the blame is appointed, what consequence does the individual or corporation suffer due to these mistakes? I will voice my opinion, and will also look at several case studies where a robot did malfunction and did cause harm.

Foster Miller is a very large international company currently deeply involved with the military. Their more famous robot is called the TALON, which has many different models for different uses both for the military, and other purposes. Two controversial versions of

the TALON robot are the SWORD robot and the MAARS robot. SWORD robots have been deployed in Iraq, and are currently in use by the military. They are armed remotely controlled robots that operate using tracks and have many sensors and cameras. The MAARS, which stands for Modular Advanced Armed Robotic System, is the predecessor of the SWORD robot. It is equipped with a more powerful weapon, and has improved situational awareness, and command systems. As you can see, robots with weapons are already involved in military operations and the matter of responsibility definitely comes into play.



FIGURE 3: FOSTER-MILLER TALON SWORDS

BAE Systems prides themselves in their goals. They state that they are "a global company engaged in the development, delivery and support of advanced defense, security and aerospace systems in the air, on land and at sea." BAE Systems is also developing what they call an ARV, which stands for Armed Robotic Vehicle. Unlike Foster Miller, this robotic vehicle will be very large. The robot will excel in

Reconnaissance, Surveillance and Target Acquisition. This last ability is of high interest, in terms of responsibility. Target Acquisition is a very precise system and a mistake could mean the targeting of a civilian or ally soldier. If that system were to fail, who would take responsibility for the potential problematic outcomes?



FIGURE 4: BAE SYSTEMS ARMED ROBOTIC VEHICLE (ARV)

Although iRobot has a large part of their business in selling robots to the public such as the Roomba, it also has a powerful military development section. Among their many ground robots, they have a robot called the iRobot Warrior. Even though it is not actually equipped with weapons, it will perform important tasks such as transporting weapons and other heavy equipment. If a robot like this malfunctions or gets attacked and disabled, whose fault is it if dangerous equipment is stolen or misfires? iRobot also has an amphibious robot known as the Transphibian. This robot is intended to be used

as harbor defense. If this becomes the only form of long range intrusion detections, who would be responsible if a robot fails to detect an enemy?



FIGURE 5: TRANSPHIBIAN BY IROBOT

Raytheon's primary focus is defense and government oriented. Their motto is simple, it states, “Aspiring to be the most admired defense and aerospace systems supplier through world-class people and technology.” One area that Raytheon specializes in is missile systems. As technology progresses, these systems are becoming more and more autonomous. Current missiles in development by Raytheon have many guidance systems where initial input is given, and then the missile autonomously navigates to its target. Obviously there are many aspects to this that create responsibility issues. If a missile malfunctions and strikes an unintended target, someone is responsible, but who?

Rafael Capurro has written many works on the ethics of robotics, including one paper written in 2007 called “Ethics and Robotics”. This paper touched on several key points about where responsibility lies in what he called “techno-ethics” issues. Towards the end of the paper, he makes his opinion clear on this controversial topic.

Capurro calls attention to the fact that there are different levels of responsibility in every case. Responsibility of an individual relies on many factors, such as the person’s well

being, their specific role in the case, their societal ties, or "as a human being at all". Capurro believes that robots are, rather than human slaves, "tools for human interaction". [18] This implies that it is currently nearly impossible to place any responsibility on the robot itself. He ends his paper with a very powerful line: "Different cultures have different views on autonomy and human dignity". It seems, according to Capurro, responsibility is not going to be a clear cut definition, but rather a constantly changing opinion, based on the specific society in question, and the roles and aspects of each human involved.

John Sullins is an assistant professor at Sonoma State University. His main focus in his ongoing research is the study of artificial intelligence and artificial life, and how they tie into traditional philosophical studies. In 2006 he wrote a paper for IRIE (International Review of Information Ethics), about robotic morality, autonomy and responsibility.

He makes his views on robotics responsibility very clear in later portions of his paper. He states "we can ascribe moral agency to a robot when the robot behaves in such a way that we can only make sense of that behavior by assuming it has a responsibility to some other moral agent(s)".[19] To put it simply, we can only give a robot responsibility for its actions, if the actions it executed appear to be driven by a moral sense of responsibility. This implies that responsibility placement is in the hands of engineers who develop robots. If the developers give the robot moral responsibilities, it is then responsible for its actions. He also states that this sense of responsibility does not have

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[18] Rafael Capurro, (http://www.capurro.de/ethicsandrobotics.html)

[19] John Sullins (http://sonoma.academia.edu/JohnSullins/Papers)

to be actual, but only an apparent set of moral values. The robot does not actually have to have a true consciousness or “soul”, just the established beliefs.

Based on what I have read and what has been presented in this paper, my opinion on where responsibility lies when it comes to robots is not at all simple. Where blame or responsibility is placed is based on many different contributing variables. How much intelligence was the robot programmed with? What were the robot’s designer’s goals with the creation of said robot? Was the robot’s actions expected, or was there simply some bug that occurred in programming? Once all these questions, and more, are answered, responsibility can truly be assigned. Whether it is the robot itself, the company responsible for the development, the potential operator of the robot, or perhaps the programmer who wrote the code, all possible factors must be weighed before a decision can be made.

MEDIA PERCEPTION OF ROBOTS

In this section I will cover the issue of media’s perception of robots. To an engineer a robot is designed to simplify and provide more accuracy to our every day needs. To the average person seeing a robot on TV think it’s an uncontrollable walking, talking metal humanoid. Robots have a large role in our culture and the perception in the media has affected their acceptance into the public.

Since the early twentieth century we have been bombarded with science fiction plays, books, movies and TV shows that show these made up robots. Although science fiction is great for the imagination, the problem is if one can distinguish between these two worlds of robots.

In the 1920s until the 1950s robots were portrayed as evil entities with only a few exceptions. Many of these showed robots attempting to take over humans. Robots were then later portrayed as friendly machines that were helpful which is shown in “The Jetsons” and “Star Wars.”

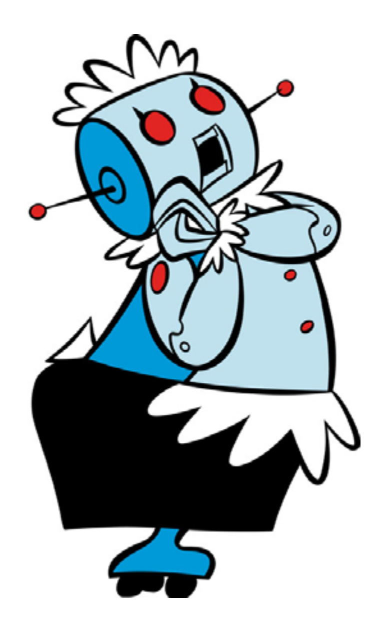


FIGURE 6: THE JETSONS

Although robots have a great ability it is overlooked by what’s seen on TV. This problem comes from the idea about fictional robots block the reality of actual designed robots. In

the eighteenth century the “metal man” was created by the Droz brothers and the “metal man” could do what humans can do. Instantly this brought two different opinions to peoples mind. Some people looked at this idea with a positive perspective, thinking that a "metal man" can make their lives easier by doing the dangerous or repetitive tasks for them. Yet some people disliked the idea of the "metal man" because they feared it would run away and do as it pleased. People also started to think that these robots could take over jobs that families depended on. People were also concerned about the ability to relate to robots since they lacked emotion.

Isaac Asimov was another influence to the perception of robots after he wrote 470 science fiction books. Asimov came up with the “Three Laws of Robotics” which were illustrated in his books about robots. The “Three Laws of Robotics” were (1) “A robot may not injure a human being or, through inaction, allow a human being to come to harm, (2)A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law (3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law”.

In many movies robots were portrayed as villains who turned on their master instead of kind and sympathetic robots. Fictional robots were seen as uncontrollable beings that were metal, had mono-toned voices and wanted to cause mass destruction. Asimov portrayed robots in a more positive way showing that they contained emotions and could sympathize with humans.

A modern view of robots in the media is in the movie "Terminator 2: Judgment Day". In this movie, a nuclear holocaust has occurred in the 20th century and an advanced android is sent back in time to prevent another man from the future by stopping the nuclear bomb from being blown up. The robot, the Terminator, contained features such as enhanced senses by altering his voice and adapting to new situations.

Appendix B: "Ethics of Military Robotics" Essay

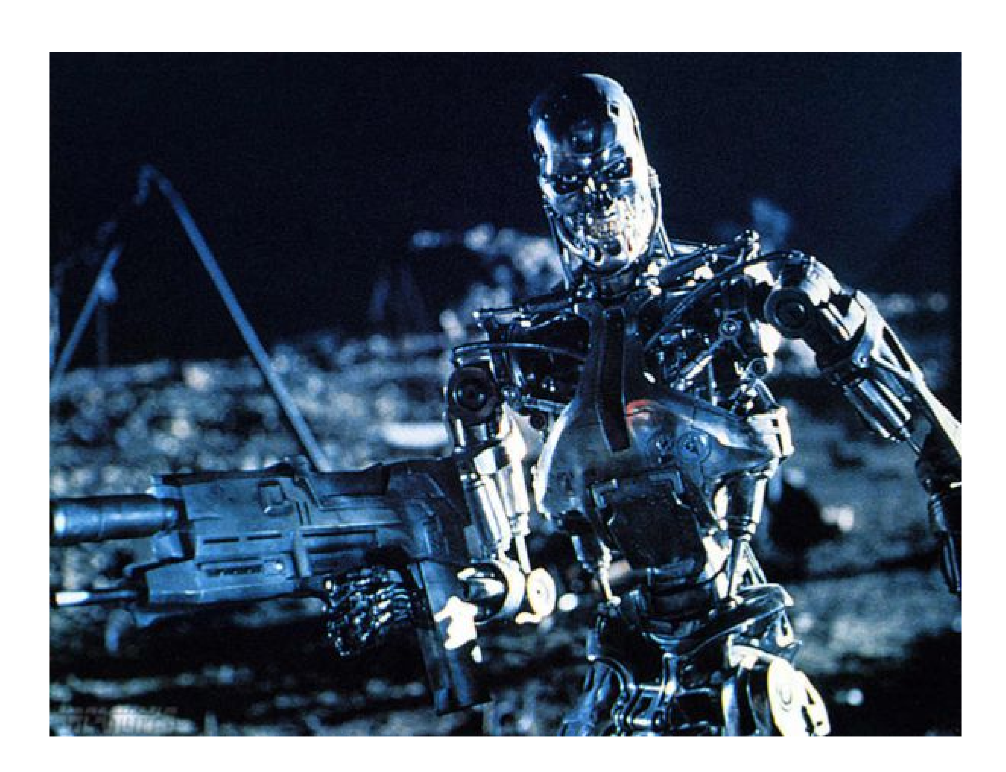


FIGURE 7: TERMINATOR 2

The movie I, Robot is based loosely on a novel by Isaac Asimov, which is a series of short stories, the "I, Robot" movie features Will Smith who plays the lead character, Del Spooner. Del Spooner is a city cop with a serious phobia of robots. Taking place in the year 2035, Del becomes involved in a murder case filled with deception, robots, and the attempted takeover of the city by an ultra-smart robotic system.

This movie is filled with implications of robotic ethics and possible roles of robots in our future lives. The movie revolves around a series of home service robots that do everything from cooking and laundry, to taking care of children and taking dogs for walks. The robots have become such a huge part of everyone's lives, and they are relied on so much, that an ultra-smart robotic system decides we are too dangerous to ourselves and uses the fact that robots are in almost every home, to initiate a complete shutdown of society as we know it.

One can sense a constant undertone of warning throughout the movie. A warning that says we should be very careful how far we develop robotic artificial intelligence. As with all movies, the implications are exaggerated for Hollywood, but the message is still clear.

In the movie Wall-E, an animated movie, is about a small trash-compacting robot that is left alone on Earth after humans destroy their environment and leave on large spaceships. This robot proceeds to meet another robot named EVE, who brings him to the human spaceship where he discovers he is not alone.



FIGURE 8: WALL-E

The movie largely revolves around two main aspects. The first is purely environmental in that humans destroyed their world with all of the industrialization and lack of care for the atmosphere. The other aspect, much more relevant to robo-ethics, is humanity’s development of robots to do everything for them. In the story, this over “robotication” of life causes humans to become so lazy that the complete lack of movement resulted in no muscle formation. The way the humans move around, and live their daily life is all through the help of robots who control everything. The main robot in charge of all operations has decided humans are not fit to return back to earth to try and re-populate, so continues to fly them around the galaxy with no plan of return.

The constant warning in this movie is to not overuse robots in our everyday lives. It is feared that letting robots become too integrated into our lives will lead to a 100% dependence on them. This concern is very real, in that everyday a new mechanical solution is developed to ease our day-to-day lives.

Appendix B: “Ethics of Military Robotics” Essay

The Matrix trilogy is a very famous story about a man who discovers he has lived his whole life in a virtual reality. In the world of The Matrix, most of the human population is actually hooked up to an advanced computer system and are actually held in small pod cells, bred and raised by robots. A small group of humans live outside “the matrix” and are constantly at war with this advanced society of robots and artificial intelligence. The main character is contacted by this group of humans and taken out of the matrix to help fight, because he is believed to be “the one” who will be able to win the war for the humans.

The timeline of “The Matrix” is supposedly supposed to take place after a massive war broke out between humans and their robots that they accidentally made too advanced. The result of the war, won by the robots, is that all humans were killed and re-bred to be used to power the robots. To keep these “human batteries” alive and unsuspicious, they created “the matrix”, a fake world.

This movie basically presents a role reversal of humans and robots in our society today. Currently, robots are used for tasks that humans don’t want to do, or would like to be assisted with. In “The Matrix”, humans have become simply a source of energy for the new “race” of robots. There are ethical issues deeply embedded all over this movie. The question of what is real, and what a true human is, make constant appearances throughout the series.

VIDEOGAMES AND WAR

Videogames and war have both changed drastically in the past few decades. The outcome of a war has become a dependent on information instead of actual combat. Gone are the heroic days of carpet bombing aerial dogfights. There is no need to bomb an entire city when a cruise missile is accurate enough to find its way through a specific window in a building. Videogames have become far more accurate and detailed as well; simple games such as *Pong* and *PacMan* have been replaced by games such as *Call of Duty* and *Gran Turismo*, both boasting a large amount of realism and amazing attention to detail. Many games even go through telling a story, putting the player in the role of the protagonist, often in ways more epic than even the largest Hollywood blockbuster. The concurrent evolution of technology, videogames, and war may very well shape the future of military conflict around the world.

The idea of a purely autonomous fighting force, which could merely be ordered to go here, shoot that, protect this building, etc, could lead many people to think of an interface similar to the genre of videogames known as "Real Time Strategy" (RTS) games. Some examples of these games include the Command and Conquer series, the world renowned Star Craft, as well as the topical Total Annihilation and Supreme Commander games. In *Total Annihilation*, and its spiritual successor, *Supreme Commander*, the player controls a force of purely robotic units ranging from construction platforms, mobile gun emplacements, autonomous bombers, and bipedal sniper robots.



FIGURE 9: SCREENSHOT FROM SUPREME COMMANDER, VAST NUMBER OF DIFFERENT AUTONOMOUS UNITS ENGAGING IN BATTLE

The concept of a similar robotic fighting force leads to many questions involving such games. These questions could include: What happens when one nation develops such a system before another? Are these games, which often feature a grim prediction of the future, a prediction of things to come in the world we live in? Also, since these games all have a rudimentary artificial intelligence which the players compete against, would the creators of reality's robot army place an AI in charge of issuing the commands to the fighting force? Many people may see a startling parallel between this idea and *Skynet* the computer system in the *Terminator* movie and television show series' which became self-aware and revolted against those that created it, humanity.

A simplistic system of similar ideology existed (and possibly still does) during the Cold War in Soviet Russia. The "Perimeter" system, often affectionately known as *Mertvaya*

Ruka, or Dead Hand, was designed such that if the US were to cripple the USSR in a nuclear strike, the system would automatically fire back with the USSR's large arsenal of nuclear armaments. The system was designed to lay dormant until activated by a high ranking official during a time of crisis in which it would monitor a number of sensors to sense a nuclear explosion, and then attempt to establish communications with the main war room. If it could not reach the head of the USSR's military command, it would transfer all control of the nuclear arsenal to a hidden bunker that could be manned by anyone from a high minister to a recruit fresh out of training. If the missiles were launched, their internal AI's would work with one another to command any remaining missiles toward their desired targets.



FIGURE 10: COVER OF THQ'S SUPREME COMMANDER, A ROBOT CENTRIC REAL TIME STRATEGY GAME

Appendix B: "Ethics of Military Robotics" Essay

The main plotline of *Supreme Commander* involves a conflict between 3 factions, each claiming superiority in a bloody or oily rather, since very few organic beings are actually killed, conflict. Thousands of units are destroyed in the conflicts. One must ask themselves: could this be what the world comes to in the future? A few humans behind computers commanding hoards of autonomous warriors to wage wars across continents, all over things which would only cause relatively small debates in a modern world? Of course, many factors control whether such a future will become a reality.



FIGURE 11: PAIR OF DARPA URBAN CHALLENGE COMPETITORS MEETING AT AN INTERSECTION

The American Military is already headed toward such autonomous systems. The Defense Advanced Research Projects Agency (DARPA) sponsors a number of engineering competitions which feature innovations in applications such as autonomous navigation. The most well known of these competition ,the DARPA Grand Challenge

and the DARPA Urban Challenge, require teams to construct autonomous vehicles to navigate around an unknown environment, depending only on sensors and their own computing power: no human input is allowed.

Something as innocent as facial recognition software for cameras could eventually be applied to a targeting system on a robotic soldier. This example is only one of a limitless number of applications for seemingly mundane technology to become something lethal.   Even modern technology could be applied to a RTS-style battle command system. The detailed live visuals could be seen through the eyes of a Global Hawk UAV flying far away in the distance, and the tactical information could be relayed between the individual robots and the command station through satellite communications, as well as relaying data between one another with close range communications. The only thing keeping such systems off of the battlefield currently is the hardware itself; the cost of such systems as seen in Figure 9 would be massive compared to training a squadron of soldiers and equipping them to do battle.

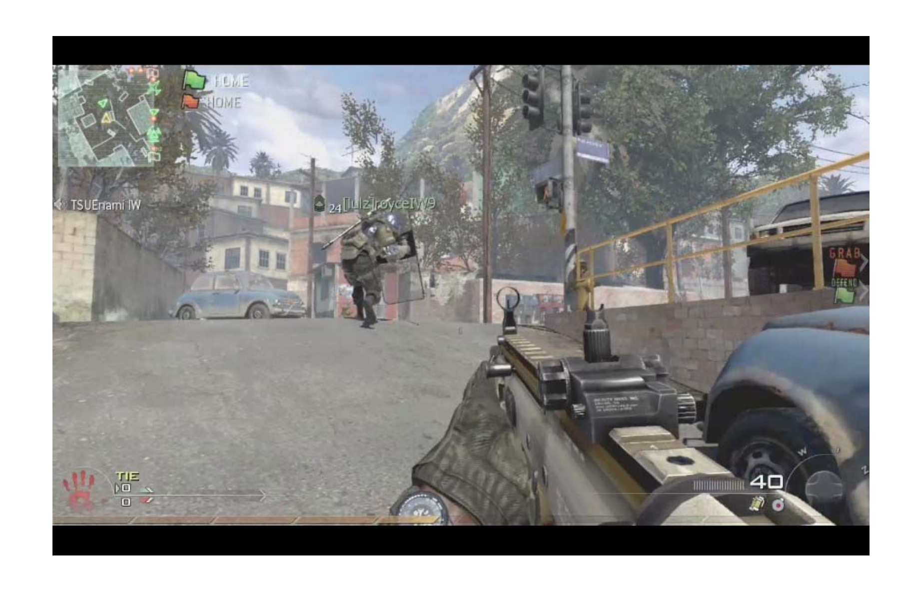


FIGURE 12: CALL OF DUTY: MODERN WARFARE 2 PLAYER IS WIELDING A FABRIQUE NATIONAL DE HERSTAL SCAR-H BATTLE RIFLE

Videogames are changing our military in other ways as well. The US Army has even released a series of videogames as a public relations project. The aptly titled game, *America’s Army*, was released on July 4, 2002. The most recent version, number 26, was released in 2009*.* *America’s Army* is not a RTS like *Supreme Commander*; it is a First Person Shooter (FPS) where the player’s screen is designed to mimic the view that his or her avatar would have in the virtual world. Other popular members of the FPS genre include the *Halo* series, *Counter Strike*, and the *Call of Duty* series. The most recent incarnation of *Call of Duty, Modern Warfare 2*, takes place in an alternate, but not too distant future. The US and NATO forces are in conflict with various terrorist groups throughout the world. Previous versions however, have been set in historic contexts. Many have found the storyline of *Call of Duty* to be very thrilling, and more engaging than a book or documentary. It is much more memorable when one is virtually living through the famous battle, as opposed to hearing a history teacher bloviate tirelessly. The amount of detail that is put into games such as *Modern Warfare 2* is truly astounding. The creators track down examples of each piece of equipment in the game to use as a reference for the games, modeling not only the geometry of the objects, but the way they interact with the player as well. Simple little things, such as the animations for reloading each firearm are different, and accurate.

Technology is evolving at an alarming rate, and concepts developed in other industries have been applied to other areas as well. The evolution of videogames and the systems that they run on is changing at a rapid rate. A few decades ago no one would have thought of the type of videogames available today. The applications of robotics and autonomy to warfare are truly amazing; in the next few decades it will be very

interesting to see what kinds of systems are developed. War may become something very like a Real Time Strategy game; however, this game will have no reset button.

CONCLUSION

In conclusion, although the initial research produced a lot of valuable and interesting information, there was much lacking. It was simply not possible to go into enough detail to fuel a whole project. There are many knowledgeable researchers out there doing very interesting work involving robotics, however the information on the ethics of the aforementioned research is far and few between. Based on this initial research, it was decided that the project should be taken in a new direction.

SOURCES

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Thompson, Nicholas. Inside the Apocalyptic Soviet Doomsday Machine. 21 09 2009. 2010 <http://www.wired.com/politics/security/magazine/17-10/mf_deadhand>.

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Appendix C: Symposium Event Introduction

Hello everyone and welcome to the WPI RoboEthics Symposium. My name is Sabrina Varanelli and I am the primary coordinator for this event. I am a mechanical and robotics engineering student here at WPI and will be graduating in May.

This event was created and put together as part of my Interactive Qualifying Project, or IQP. The IQP is a mandatory WPI project in which students relate science and technology to society. This event would not have been possible without the rest of my IQP group,   , Jola Myrta, also a senior graduating with a degree in Electrical Engineering Andrew Haggerty and Alex Scott, both junior Robotics majors and our exceedingly supportive advisor Professor Taskin Padir.

This event was timed to coincide with an program called "National Robotics Week," the product of a 2009 effort by leading universities and companies to create a "national road-map" for robotics technology, which was initially unveiled at a May 2009 briefing by academic and industry leaders to the Congressional Caucus on Robotics. This weeklong event strives to celebrate the United States as a leader in robotics technology development, educate the public about how robotics technology impacts society, advocate for increased funding for robotics technology research, and to help inspire students of all ages to pursue careers in robotics and other Science, Technology, Engineering-related fields. This program serves as a framework for a variety of robotics-related events happening between today and April 18.

Like me, many of you are fascinated by robots. When you see a mass of machinery electronics and software working together to do a task, something in your brain says "wow…that's totally cool."

Next your brain probably moves into "optimization mode" and you start thinking of ways that the robot could be improved or applied to work in another situation.

After that the engineer in you takes over and you start designing this optimization

…and then you build it….

….and then you test it…

…and then you think about how to make it better….

…and then you build it….

….and then you test it…

…and then you think about how to make it better….

…and then you build it….

….and then you test it…

And before you know it you are stuck in an infinite loop of working on this device.

Very rarely during the engineering process do we stop and think about how our creation will eventually affect society as a whole.

As engineers, we can all admit that we have gotten caught up in this "infinite loop" of designing, implementing and improving, and haven't taken the time to think about what it's overall effect will be. **But as humans**, we need to realize that we don't live in a nice self-f contained loop all alone and that the effects that our actions have on our world **do** concern us and need to be seriously considered.

I discovered my love for robots my freshman year of high school thorough the FIRST robotics program. This program seeks to introduce students to the limitless opportunities that science and technology can bring by setting up robotics competitions that consisted of games and challenges that the robots had to accomplish. Back then, everyone thought robots were cool …well at least cool in a nerdy kind of way. These robots were "harmless." They played a game and other than serving as an inspiration for kids to go into engineering and science related fields, they didn't really have a controversial effect on society.

My experiences on the FIRST team in high school let me to an internship at a global defense company called BAE Systems. For the past three summers I have been interning there and one of my main projects involved working on the manned ground vehicle—a semi autonomous hybird electric tank—for the recently-discontinued Future combat systems program.

Making this jump from building robots "for fun" to working on robots that were potentially lethal seemed like a logical step to me. After all, the FIRST program was to get people interested in robotics, so taking it to the "next level" by working for a company seemed like the natural progression of things to me. At this point though, I was stuck in my own innocuous infinite loop.

At a family bbq I attended during my first year working on the program, I was meeting my cousin's girlfriend for the first time. We were chatting and the subject of work came up. I explained to her the basics of my internship, and how I was working on this totally sweet robotic tank. Her response wasn't the "oh wow that's so cool" response that I had gotten from the rest of my family. Instead she said, "Oh, so you kill people for a living."

I was completely taken aback by her statement. The company's motto of "we protect those who protect us" was the first thing that came to mind as an answer and I tried to explain how we were saving lives by making robotic systems to fight instead of people.

The response she gave to each of my arguments was, "but there's still fighting…there are still people begin killed and you're contributing to it."

Ethics of my situation aside, this incident really started to get me to think about how robotic technologies have a broad impact on the world as a whole, and how my work as a future robotics engineer was directly shaping this impact. As I thought more and more about my work with military robotics, the more I wondered if what I was doing was morally ok. Eventually I was able to make up my own mind, but I was now fascinated with the topic.

Appendix C: Symposium Event Introduction

Since I was also trying to come up with an idea for a unique IQP around this time, I decided that it would be **a study** to explore the issues that I had encountered. So I got a group together and we started doing preliminary research for our paper titled, "The Ethics of Military Robotics." As we did initial research, we discovered that there was little material to base our research on, and that robotics and ethics as a topic in general was not something that was widely considered. From this lack of discussion on these critical topics, I came up with the idea for this symposium to be a forum for discussion on robot/ethics related issues.

As the leader in the emerging Robotics Industry, WPI essentially has a social responsibility to help make people aware of these potential issues and to stimulate discussion that will encourage future roboticists to think hard about these concerns, and to make up their own minds about what they think is right. As pioneers in the industry, we as individuals also have a social responsibility to learn about the potential consequences of our actions and to act in the way we see fit.

The purpose of this symposium is not to tell you that robots are good, evil or that you shouldn't take that job offer that yolu just got at a military robotics company. Our goal here is to help make people aware that there are ethical issues that must be considered by an engineer working with robots. We want to promote discussion of these critical issues and as a result have taken a unique approach to the organization of this conference by including small-group debate sessions. We want to provide a forum for the discussion of these critical issues for engineers, students, members of industry and academia and non technical persons alike.

Stan Lee, the author of the Spiderman comic series wrote that "with great power also comes comes great responsibility." As roboticists we have great power to influence our world through our creations and with that comes the responsibility to ensure that we are acting in a way that is socially responsible. Being aware of issues that come as a result of your actions is the first step to making these socially responsible choices.

I would like to welcome you all again to the WPI RoboEthics Symposium and would now like to introduce Professor Michael Gennert, head of the WPI Robotics program.

Appendix D: Event Poster

WPI RoboEthics

SYMPOSIUM

SERVICE

MEDICAL ROBOTS

MILITARY ROBOTS

Saturday, April 10

9:45am–4:45pm

WPI Campus Center

Third Floor Odeum and Conference Rooms

Learn about the ethical issues surrounding the use of robots. Participate in this interactive forum for technical and nontechnical discussion. Network with students, faculty, and industry professionals.

Recognizing the social responsibilities associated with being a pioneer in an emerging industry, WPI is, through this symposium, taking steps to ensure that future generations of engineers and scientists are aware of the impact of their actions.

In addition to lectures and keynote speakers, the WPI RoboEthics Symposium will offer a series of interactive debate sessions for participants to actively engage in discussion on topics relevant to ethics and to their interests.

"With great power there must also come… great responsibility"

Stan Lee, Creator of the Spiderman Comic Series

Keynote Speakers:

Ron Arkin, Regents Professor and Director of the Mobile Robot Laboratory at Georgia Institute of Technology, Associate Dean for Research in the College of Computing

Noel Sharkey, Professor of AI and Robotics, and Professor of Public Engagement, Department of Computer Science, University of Sheffield

Plus:

Professionals from the robotics industry
Members of the WPI faculty
WPI student Interactive Qualifying Project groups

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www.roboethics.wpi.edu

The WPI RoboEthics Symposium is sponsored by the Robotics Engineering Program.

Appendix E: Keynote Speaker Biographies

Keynote Speaker Biography



Noel Sharkey

University of Sheffield, UK



Noel Sharkey BA PhD FIET, FBCS CITP FRIN FRSA is a Professor of AI and Robotics and a Professor of Public Engagement at the University of Sheffield (Department of Computer Science) and a writer, broadcaster and journal editor. Noel has moved freely across academic disciplines, lecturing in engineering, philosophy, psychology, cognitive science, linguistics, artificial intelligence, computer science and robotics. He appears regularly on TV and is interviewed regularly on radio and in the press. As well as writing many academic articles, he also writes for the national newspapers and magazines and has been involved in thrilling robotics museum exhibitions and mechanical art installations. Noel has a passion for engaging the public is discussions about the ethical implications of new technologies. www.dcs.shef.ac.uk/~noel

Keynote Speaker Biography





Ronald Arkin

Georgia Institute of Technology

Ronald Arkin is Regents' Professor and Director of the Mobile Robot Laboratory at the Georgia Institute of Technology. He serves as the Associate Dean for Research in the College of Computing. During 1997-98, Professor Arkin was STINT visiting Professor at the Royal Institute of Technology in Stockholm. In 2005-06, Prof. Arkin held a Sabbatical Chair at the Sony Intelligence Dynamics Laboratory in Tokyo and then was a member of the Robotics Group at LAAS in Toulouse. Dr. Arkin's research interests include behavior-based reactive control, action-oriented perception, hybrid deliberative/reactive robotic architectures, robot survivability, multiagent systems, biorobotics, human-robot interaction, robot ethics, and learning in autonomous systems. He has over 170 technical publications in these areas. Prof. Arkin has written a textbook entitled Behavior-Based Robotics, co-edited Robot Colonies, and a new book entitled Governing Lethal Behavior in Autonomous Robots. Funding sources include the NSF, DARPA, U.S. Army, Savannah River, Honda, Samsung, Draper, SAIC, NAVAIR, and ONR. Dr. Arkin is an Associate Editor for numerous journals and is Series Editor for the MIT Press book series Intelligent Robotics and Autonomous Agents. Prof. Arkin serves on the Board of Governors of the IEEE Society on Social Implications of Technology, served on the Administrative Committee of the IEEE Robotics and Automation Society, is a founding co-chair of the IEEE RAS Technical Committee on Robot Ethics, is co-chair of the Society's Human Rights and Ethics Committee, and served on the NSF's Robotics Council. He is a Fellow of the IEEE, and a member of AAAI and ACM.
http://www.cc.gatech.edu/aimosaic/faculty/arkin/

Appendix F: Presentation Abstracts

Keynote Abstract



Doing What's Right with Robots: An Ethical Appraisal

Noel Sharkey, University of Sheffield

Would you let robots care for your children, mind your aging parents, perform surgery on you, protect your home and fight your wars? Since the turn of the century, sales of professional and personal service robots have risen sharply to an estimated 11.5 million by 2011 Their numbers already far outstrip the 1.2 million operational industrial robots on the planet. Service robots are good at dull, dangerous, and dirty work, such as cleaning sewers and performing domestic duties. They harvest fruit, pump gasoline, assist doctors and surgeons, dispose of bombs, police us, entertain us, have sex with us and even kill us. This talk will briefly overview today's service robots and their benefits and then focus on the near-future ethical dangers that they pose.

Keynote Abstract



Ethics and Lethality in Autonomous Combat Robots

Ronald Arkin, Georgia Institute of Technology

Weaponized robotic systems are being introduced into the battlefield at an ever increasing pace. The consequences of this technological progress need to be examined carefully. In this talk, I outline the philosophical basis, motivation, theory, and design recommendations for the implementation of an ethical control and reasoning system potentially suitable for constraining lethal actions in an autonomous robotic system so that they fall within the bounds prescribed by the Laws of War and Rules of Engagement. It is a further contention that an autonomous robot capable of lethal force can ultimately be more humane in the battlefield than human soldiers. Robot architectural design recommendations are presented for (1) post facto suppression of unethical behavior, (2) behavioral design that incorporates ethical constraints from the onset, (3) the use of affective functions as an adaptive component in the event of unethical action, and (4) a mechanism in support of identifying and advising operators regarding their ultimate responsibility for the deployment of such a system.
This research was supported under a grant from the Army Research Office

Presentation Abstract



A Code of Ethics for Robotics Engineers

Brandon Ingram, Daniel Jones, Andrew Lewis, Matthew Richards

Robotics engineering presents many new situations that engineers in other fields have not had to deal with, such as autonomous decision making, advanced human interaction and the possibility of autonomous lethality. No other professional code of ethics had been created with these specific situations in mind, and this was seen as something that needed to be fixed. This team of students created such a code of ethics as a way to unify robotics engineers under a single code of ethics and conduct. The code is open for discussion at rbethics.lefora.com

Appendix G: Event Website Images

home | program | venue | debate | register | wpi | contact



Worcester Polytechnic Institute



This event will take place on the second floor of the **WPI Campus Center in the Odeum.**

Founded in Worcester, Mass., in 1865, WPI was one of the nation's earliest technological universities. From our founding days, we've taken a unique approach to science and technology education.

Parking Information

The WPI Quad parking lot has been reserved for this event. Please see the map in the "Useful Information" bar to the right for more information.

Useful Information

- WPI
- About WPI
- WPI Robotics
- Directions
- Lodging Information
- Campus Map
- Campus Phone Numbers

WPI RoboEthics

SYMPOSIUM

APRIL 10, 2010

RoboEthics Symposium Registration Form

Please fill out the below fields to register for this event.
A few days before the event, you will receive an email to confirm your attendance.

* Required

Title

(Mr, Ms, Dr, etc)

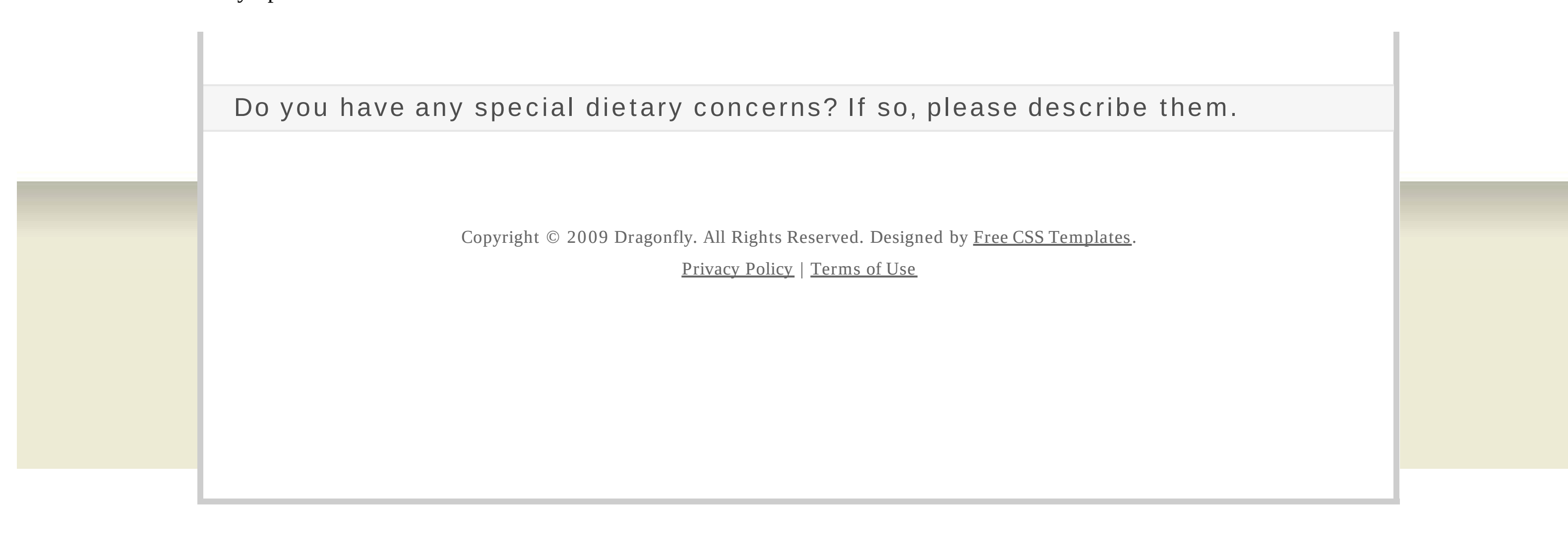
First Name *

Last Name *

Affiliation

(Company, School, Organization, etc)

Email Address *


Do you have any special dietary concerns? If so, please describe them.
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WPI RoboEthics

APRIL 10, 2010 SYMPOSIUM

Proposed Symposium Agenda

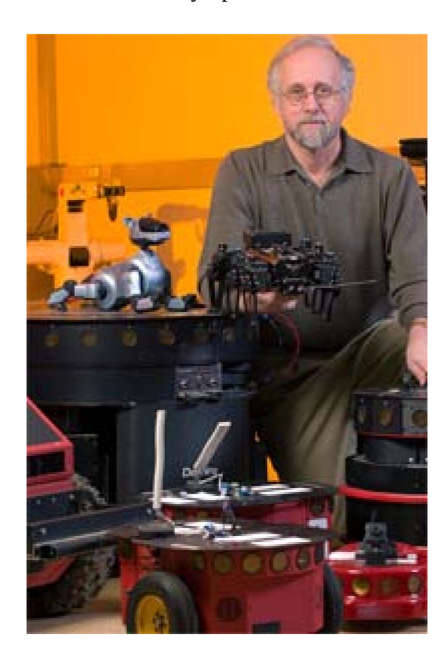
Time	Activity
9:45	Registration & Coffee Served
10:10-10:40	Introductory Remarks: Michael Gennert
10:50-11:50	Keynote #1: Noel Sharkey, "Doing What's Right With Robots: An Ethical Appraisial"
12:00-12:40	WPI Project Group, "A Code of Ethics for Robotics Engineers"
12:40	Lunch Buffet & Networking
1:10 - 2:10	Keynote #2: Ronald Arkin, "Ethics and Lethality in Autonomous Combat Robots"
2:20 - 3:10	Debate Session #1
3:20 - 4:10	Debate Session #2
4:20 - 4:45	Closing Remarks

*****Please note the change in start time*****

Keynote Speakers

Ronald Arkin
Georgia Institute of Technology

Ronald Arkin is Regents' Professor and Director of the Mobile Robot Laboratory at the Georgia Institute of Technology. He serves as the Associate Dean for Research in the College of Computing. During 1997-98, Professor Arkin was STINT visiting Professor at the Royal Institute of Technology in Stockholm. In 2005-06, Prof. Arkin held a Sabbatical Chair at the Sony Intelligence Dynamics Laboratory in Tokyo and then was a member of the Robotics Group at LAAS in Toulouse. Dr. Arkin's research interests include behavior-based reactive control, action-oriented perception, hybrid deliberative/reactive robotic architectures, robot survivability, multiagent systems, biorobotics, human-robot interaction, robot ethics, and learning in autonomous systems. He has over 170 technical publications in these areas. Prof. Arkin has written a textbook entitled Behavior-Based Robotics, co-edited Robot Colonies, and a new book entitled Governing Lethal Behavior in Autonomous Robots. Funding sources include the NSF, DARPA, U.S. Army, Savannah River, Honda, Samsung, Draper, SAIC, NAVAIR, and ONR. Dr. Arkin is an Associate Editor for numerous journals and is Series Editor for the MIT Press book series Intelligent Robotics and Autonomous Agents. Prof. Arkin serves on the Board of Governors of the IEEE Society on Social Implications of Technology,



served on the Administrative Committee of the IEEE Robotics and Automation Society, is a founding co-chair of the IEEE RAS Technical Committee on Robot Ethics, is co-chair of the Society's Human Rights and Ethics Committee, and served on the NSF's Robotics Council. He is a Fellow of the IEEE, and a member of AAAI and ACM. http://www.cc.gatech.edu/aimosaic/faculty/arkin/



Noel Sharkey
University of Sheffield, UK

Noel Sharkey BA PhD FIET, FBCS CITP FRIN FRSA is a Professor of AI and Robotics and a Professor of Public Engagement at the University of Sheffield (Department of Computer Science) and a writer, broadcaster and journal editor. Noel has moved freely across academic disciplines, lecturing in engineering, philosophy, psychology, cognitive science, linguistics, artificial intelligence, computer science and robotics. He appears regularly on TV and is interviewed regularly on radio and in the press. As well as writing many academic articles, he also writes for the national newspapers and magazines and has been involved in thrilling robotics museum exhibitions and mechanical art installations. Noel has a passion for engaging the public is discussions about the ethical implications of new technologies. www.dcs.shef.ac.uk/~noel

WPI RoboEthics
SYMPOSIUM
APRIL 10, 2010

Ethics for Robotics in our Changing World



As the **pioneer for undergraduate robotics** WPI recognizes that there are ethical issues that are raised in our society by facilitating the advancement of robotic development. The purpose of this symposium is to raise awareness of the ethical issues surrounding the use of robots in society by providing an interactive forum for technical and non technical discussion and networking between students and industry professionals.

"With great power there must also come... great responsibility"
Stan Lee, Creator of the Spiderman Comic Series

WPI has recognized the social responsibilities associated with being a pioneer in an emerging industry and as a result, is taking steps to ensure that future generations of engineers and scientists are aware of the impact that their actions cause on society.

Interactive Program

Participating Organizations

WPI
National Robotics Week
WPI Robotics Advisory Board

Participating Companies

Robotics Trends
ABB Robotics

In addition to the standard lectures and keynote speakers that most symposiums provide, the 2010 WPI Roboethics Symposium will be unique in that it will have a series of debate sessions for all participants to get the chance to actively engage in discussion on ethical topics relevant to their interests. For more information see the "debate" section of this document.

home | program | venue | debate | register | wpi | contact

WPI RoboEthics

SYMPOSIUM

APRIL 10, 2010

Interactive Debate Sessions



This second portion of the **WPI RoboEthics Symposium** will consist of a series of debate sessions on topics pertaioning to ethical issues surrounding the use of robotics in various applications. The purpose of these debates is to stimulate awareness and thought on ethical issues pertinent to those involved in this new "robotics revolution" and to facilitate discussion between professionals and students in the robotics industry.

These debates will be moderated and will be conducted in "round table" setting and all participants are invited and encouraged to participate. A list of sample discussion topics and directions to submit your own topics can be seen below.

Sample Debate Topics

Topics are currently being decided upon and will be on robotics topics that fall under the following categories:

- **Military**
- **Medical**
- **Industrial**
- **Child and Elder Care**
- **Security**

To suggest a topic, please email the Symposium staff at roboethics-staff@wpi.edu



Contact Information



For more information about the event, to become a speaker, or to acquire table space at our event, please contact the appropriate entity listed below.

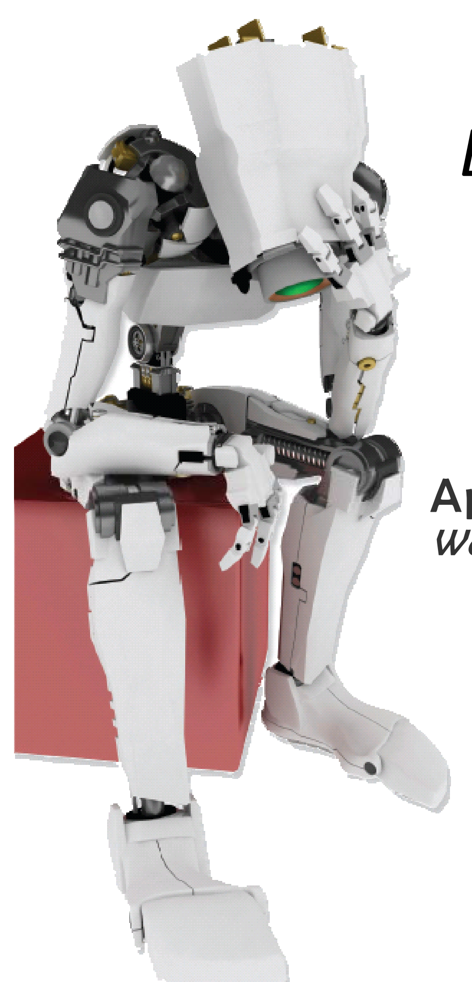
roboethics-staff@wpi.edu

roboethics-webmaster@wpi.edu

Appendix H: Event Program

WPI RoboEthics

SYMPOSIUM



Ethics For Robotics In Our Changing World

April 10, 2010

Worcester Polytechnic Institute





Why RoboEthics?

Robots have long been used to perform dull, dangerous, and dirty jobs. But as they become more sophisticated and able to make decisions on their own, robots are being considered for new roles in society, such as taking care of children and the elderly, protecting our homes, or even fighting wars. These new roles raise issues and concerns that engineers have never had to deal with, and call for new professional codes of ethics.

With great power also comes....great responsibility.

-Stan Lee, Creator of the Spiderman Comic Series

The purpose of this symposium is to raise awareness of the ethical issues surrounding the use of robots in society by providing an interactive forum for technical and non technical discussion and networking between students and industry professionals.



The idea for the symposium was created and the event organized by a team of WPI students as part of a research-driven project required for graduation from WPI, the Interactive Qualifying Project (IQP). The IQP applies science and technology to addresses an important societal need or issue.

Sabrina Varanelli, a senior double-majoring in robotics engineering and mechanical engineering, from Sacramento, CA.

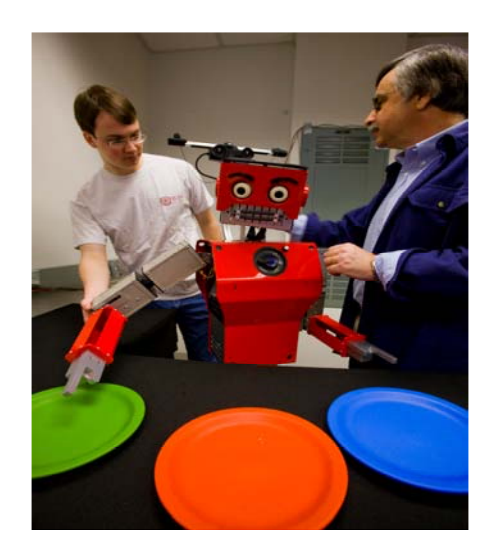
Jola Myrta, a senior electrical and computer engineering major from Worcester, MA.

Andrew Haggerty, a junior robotics engineering major from Millis, MA.

Alex Scott, a junior robotics engineering major from Aiken, S.C.

Event Schedule

Time	Activity
9:45	Registration & Coffee Served
10:10-10:40	Introductory Remarks: Sabrina Varanelli & Michael Gennert
10:50-11:50	Keynote #1: Noel Sharkey *Doing What's Right With Robots: An Ethical Appraisal*
12:00-12:40	Student Presentation *A Code of Ethics for Robotics Engineers*
12:40	Lunch Buffet & Networking
1:10 - 2:10	Keynote #2: Ronald Arkin *Ethics and Lethality in Autonomous Combat Robots*
2:20 - 3:10	Debate Session #1
3:20 - 4:10	Debate Session #2
4:20 - 4:45	Closing Remarks



Keynote Speaker



Noel Sharkey

University of Scheffield

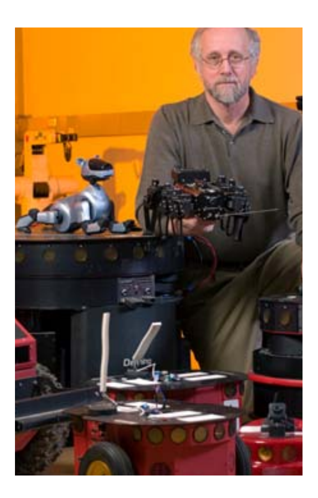
Noel Sharkey BA PhD FIET, FBCS CITP FRIN FRSA is a Professor of AI and Robotics and a Professor of Public Engagement at the University of Sheffield (Department of Computer Science) and a writer, broadcaster and journal editor. Noel has moved freely across academic disciplines, lecturing in engineering, philosophy, psychology, cognitive science, linguistics, artificial intelligence, computer science and robotics. He appears regularly on TV and is interviewed regularly on radio and in the press. As well as writing many academic articles, he also writes for the national newspapers and magazines and has been involved in thrilling robotics museum exhibitions and mechanical art installations. Noel has a passion for engaging the public is discussions about the ethical implications of new technologies.

Abstract

Doing What's Right with Robots: An Ethical Appraisal

Would you let robots care for your children, mind your aging parents, perform surgery on you, protect your home and fight your wars? Since the turn of the century, sales of professional and personal service robots have risen sharply to an estimated 11.5 million by 2011 Their numbers already far outstrip the 1.2 million operational industrial robots on the planet. Service robots are good at dull, dangerous, and dirty work, such as cleaning sewers and performing domestic duties. They harvest fruit, pump gasoline, assist doctors and surgeons, dispose of bombs, police us, entertain us, have sex with us and even kill us. This talk will briefly overview today's service robots and their benefits and then focus on the near-future ethical dangers that they pose.

Keynote Speaker



Ronald Arkin

Georgia Institute of Technology

Ronald Arkin is Regents' Professor and Director of the Mobile Robot Laboratory at the Georgia Institute of Technology. He serves as the Associate Dean for Research in the College of Computing. During 1997-98, Professor Arkin was STINT visiting Professor at the Royal Institute of Technology in Stockholm. In 2005-06, Prof. Arkin held a Sabbatical Chair at the Sony Intelligence Dynamics Laboratory in Tokyo and then was a member of the Robotics Group at LAAS in Toulouse. Dr. Arkin's research interests include behavior-based reactive control, action-oriented perception, hybrid deliberative/reactive robotic architectures, robot survivability, multiagent systems, biorobotics, human-robot interaction, robot ethics, and learning in autonomous systems. He has over 170 technical publications in these areas. Prof. Arkin has written a textbook entitled Behavior-Based Robotics, co-edited Robot Colonies, and a new book entitled Governing Lethal Behavior in Autonomous Robots. Funding sources include the NSF, DARPA, U.S. Army, Savannah River, Honda, Samsung, Draper, SAIC, NAVAIR, and ONR. Dr. Arkin is an Associate Editor for numerous journals and is Series Editor for the MIT Press book series Intelligent Robotics and Autonomous Agents. Prof. Arkin serves on the Board of Governors of the IEEE Society on Social Implications of Technology, served on the Administrative Committee of the IEEE Robotics and Automation Society, is a founding co-chair of the IEEE RAS Technical Committee on Robot Ethics, is co-chair of the Society's Human Rights and Ethics Committee, and served on the NSF's Robotics Council. He is a Fellow of the IEEE, and a member of AAAI and ACM.

Abstract

Ethics and Lethality in Autonomous Combat Robots

Weaponized robotic systems are being introduced into the battlefield at an ever increasing pace. The consequences of this technological progress need to be examined carefully. In this talk, I outline the philosophical basis, motivation, theory, and design recommendations for the implementation of an ethical control and reasoning system potentially suitable for constraining lethal actions in an autonomous robotic system so that they fall within the bounds prescribed by the Laws of War and Rules of Engagement. It is a further contention that an autonomous robot capable of lethal force can ultimately be more humane in the battlefield than human soldiers. Robot architectural design recommendations are presented for (1) post facto suppression of unethical behavior, (2) behavioral design that incorporates ethical constraints from the onset, (3) the use of affective functions as an adaptive component in the event of unethical action, and (4) a mechanism in support of identifying and advising operators regarding their ultimate responsibility for the deployment of such a system.

Student Presentation



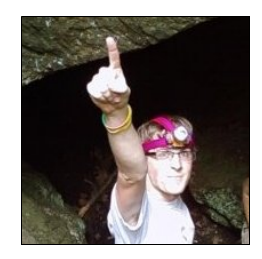
Brandon Ingram is a Junior Mechanical Engineering major. He enjoys playing the trumpet in the Pep Band and is a proud member of Alpha Phi Omega. After graduations, Brandon plan to earn a Masters Degree in Fire Protection Engineering at WPI.

Daniel Jones is a Junior studying Electrical and Computer Engineering. Dan is an Eagle Scout and an avid programmer. He is involved in several robotic initiatives at WPI, including Combat Robotics and assisting with FIRST's support of Java.



Andrew Lewis is a Junior at WPI studying Robotics Engineering. Andrew is an Eagle Scout and a proud member of Phi Sigma Kappa. He enjoys biking, climbing, machining and growing facial hair.

Matthew Richards is a junior in a Robotics and Interactive Media and Game Design double major. In fairer weather he enjoys climbing, biking, swimming, and spelunking, but in the winter he sticks to just tubing. His interests lie in bio-mechanical engineering, human-computer interaction and AI.



Abstract
A Code of Ethics for Robotics Engineers

Robotics engineering presents many new situations that engineers in other fields have not had to deal with, such as autonomous decision making, advanced human interaction and the possibility of autonomous lethality. No other professional code of ethics had been created with these specific situations in mind, and this was seen as something that needed to be fixed. This team of students created such a code of ethics as a way to unify robotics engineers under a single code of ethics and conduct. The code is open for discussion at rbethics.lefora.com .

Debate Sessions

This second portion of the WPI RoboEthics Symposium will consist of a series of debate sessions on topics pertaining to ethical issues surrounding the use of robotics in various applications. The purpose of these debates is to stimulate awareness and thought on ethical issues pertinent to those involved in this new "robotics revolution" and to facilitate discussion between professionals and students in the robotics industry.

These debates will be moderated by members from the debate team and will be conducted in "round table" setting and all participants are invited and encouraged to participate.



Each person has two colored boxes on their nametag that correspond to a different debate room that they will be in for each session. Please proceed from the left color to the right color. The colors and directions to the rooms are listed below. When the debate sessions begin, please proceed to the appropriate room.

Blue Debate Room: Top floor of the campus center, directly across from the Odeum.

Orange Debate Room: Top floor of the campus center, exit Odeum, make a left.

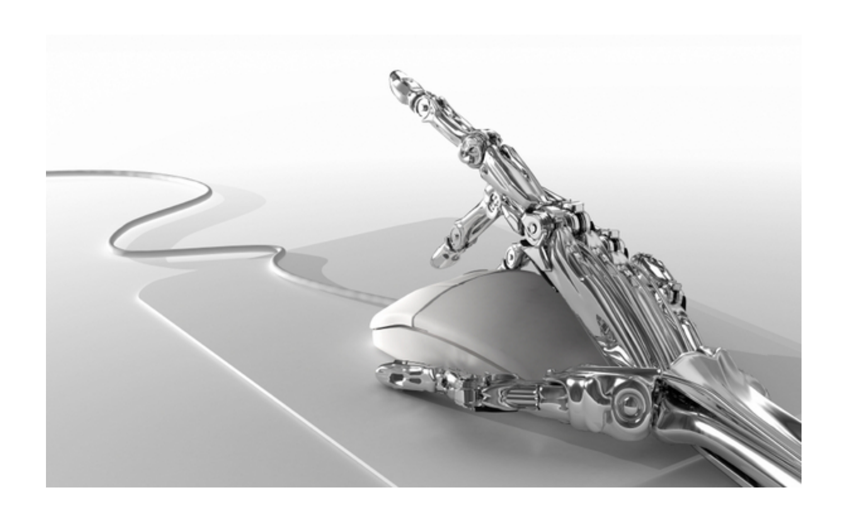
Purple Debate Room: Bottom floor of the campus center, make a right then a quick left. Room is on

Red Debate Room: Bottom floor of the campus center, make a right then a quick left. Room is on left.



This event is sponsored by the WPI
Robotics Engineering Program

www.robotics.wpi.edu



www.roboethics.wpi.edu

roboethics-staff@wpi.edu

Appendix I: Event Expenses

WPI RoboEthics Symposium Expense Sheet

					Subtotal
Speakers					***$ (1,901.35)***
		Sharkey	**Arkin**	**Total**	
	Flights	$ (169.70)	$ (341.40)	$ (511.10)	
	Hotels	$ (249.50)	$ (124.75)	$ (374.25)	
	Transportation	$ (258.00)	$ (258.00)	$ (516.00)	
	Honorarium	$ (250.00)	$ (250.00)	$ (500.00)	
Speaker's Fund					$ 500.00
Catering					$ (770.40)
	Item	**Qty**	**Cost**	**Subtotal**	
	Wrappables (sandwiches)	50	(9.45)	$ (472.50)	
	Hummus Dip (per person)	20	(0.90)	$ (18.00)	
	Chesse and Fruit tray (per person	20	(2.00)	$ (40.00)	
	Cookies!	40	(1.00)	$ (40.00)	
	Brownies	25	(0.85)	$ (21.25)	
	Blondies	15	(0.85)	$ (12.75)	
	Coffee Service	30	(1.65)	$ (49.50)	
	Water Cooler rental	2	(33.00)	$ (66.00)	
	tax	1	(50.40)	$ (50.40)	
				$ -	
				$ -	
Custodian					$ (150.00)
Posters					$ (148.07)
	Large Poster Printing	4	$ (14.00)	$ (56.00)	
	Small Poster Printing	6	$ (6.00)	$ (36.00)	
	Small Posterboard Pack	1	$ (15.49)	$ (15.49)	
	Large Posterboard Pack	2	$ (20.29)	$ (40.58)	
Name Badges		1	$ (24.49)		$ (24.49)
Program Printing		75	$ (2.50)		$ (187.50)
Speaker Gifts					$ (10.00)
	Travel Mug	2	$ (5.00)	$ (10.00)	
	TBD				
			Total:		$ (2,691.81)

Appendix J: Debate Session Presentation

WPI RoboEthics SYMPOSIUM

APRIL 10, 2010

Military

Medical

Industry

Humane

Personal

Military

- Should autonomous robots eventually replace frontline soldiers ?
- Should the rules of engagement be altered to account for the use of robots in the battlefield?
- In a worst case scenario, who should be held responsible for a friendly-fire accident involving a robot?
- Should a robot be able to autonomously decide if a perceived threat warrants the use of force?
- Are autonomous robots bound by the Geneva Conventions, and should they be able to take prisoners?

Industry

- Will automating the majority of manufacturing create more jobs?
- Should there be some sort of tax incentive to operate robotic/autonomous factories in the United States versus outsourcing the manufacturing to a foreign country?
- Will there ever be such a thing as "too much" automation?
- What level of autonomy should robots in industry settings be able to have? Should there always be a necessity for operations to be overseen by humans?

Medical

- Should there be an incentive to receive surgery from a tele-operated robotic surgeon instead of a traditional surgeon in a hospital?
- If a medical robot makes a serious mistake, surgical or otherwise, on whom does the responsibility lie.
- Should medical robots ever be allowed to do fully autonomous surgery?
- Should microscopic or intravenous robots ever be used for medical purposes?

Humane

- . As robots have the ability to reason and have feelings, what will make a human a human and a robot a robot?
- Should there be a robot for every task? Any robot you wouldn't want to see created? Where do we draw the line?

Personal

- With robots becoming commonplace in households, what level of involvement should robots have in the personal life of a family?
- When household robots have cameras, what should be the limit on personal privacy?
- Should robots be allowed to take care of children when parents are out of the house, or should daycares, nannies, and baby-sitters still be used?

Appendix K: Debate Session Recording

This .mp3 file can be found by selection “DebateSessionRecording.mp3” under the “File” section of the project title page or by contacting Professor Taskin Padir at tpadir@wpi.edu.

DEBATE SESSION SUMMARY

Jola Myrta

Andrew Haggerty

Alex Scott

CONTENTS

Appendix L: Debate Session Summary

INTRODUCTION

In the afternoon of the symposium, a group debate session was held in the Mid Century conference room, on the third floor of the Campus Center. The main purpose of this debate session was to promote discussion and interaction about major topics involving robotics and ethics in major parts of civilization. Specifically, there were 4 main topics covered; military robotics, industrial robotics, and medical robotics, and what makes a person a person and a robot a robot. What follows is a summary of what was covered in approximately an hour and a half of active debate and discussion. Complete recording of the debate is provided as a separate file in the WPI Library E-projects website.

MILITARY ROBOTIC ETHICS

The debate opened with a heated discussion about military applications of robots. The first question regarded the eventual replacement of front line soldiers with autonomous robots. The risk of the lives of these soldiers was a paramount ethical point in this discussion. Additionally, the idea that a battle between robots would be somewhat of a videogame was brought up. Another point brought up was that the average foot soldier is trained to act in a semi-robotic manner, which was rebutted by a former officer in the room. An idea that was found most interesting however, was the idea that fighting alongside or behind robots would cause the humans on the battlefield to fight in a more ethical manner; such that a robot would give the soldiers a chance to take a moment extra for thought before committing to his actions.

Dealing with a hostage situation was another prominent point which preempted much debate. The idea that a robot would be ill equipped for telling the difference between a hostage, and a combatant in disguise. The idea of a child sensing robotic grenade brought up during Dr. Arkin's speech was entertained as well. The possibility of combatants keeping children with them to counter such equipment, which they already do in reality, was considered as well.

The concept of war being, by nature, an unethical environment was a foreign idea to a few more idealistic participants. The idea that the other guy is trying to kill you, and will do so unless he is stopped first was a little hard to swallow for them. The rules of

engagement were discussed as well. It was revealed that they change on a situation by situation basis; additionally, the US Military is one of the most ethical forces on the battlefield. Any ethical issues involving robots in the military also involve humans, whether they are the pilots of the robots, their comrades in battle, or even their targets.

INDUSTRIAL ROBOTIC ETHICS

The next topic was the impact of robotics in industry. The idea that automation in manufacturing would replace many jobs was a strong topic. The concept that the work would relocate or become autonomous was a point brought up to support the movement toward autonomy in industry. The advancement toward more efficient and precise manufacturing is necessary for the increase in technology and the growing pace in the modern world. Basically, the politics can't keep up with the growth and evolution of the robotics industry. The issue developing from this is the distribution of work, and thus money. Those that design and operate the robots will potentially replace and remove those that would traditionally fill menial positions in manufacturing.

Many opinions on job security were thrown around the room. There were concerns of workers going on strike if robotics became too prominent. A solid point was brought up that it will require jobs to build and maintain robots in the future and that many of the jobs robots will do are jobs that humans shouldn't be forced to do in the first place, specifically, the three "D's", dull, dangerous, and deadly.

Another concern was brought up that jobs seem to be shifting from uneducated to educated, and that if that shift happens too quickly, there could be problems with much of the population not being smart enough to take the available jobs, thus leading to even more job loss. This was followed by a question about money from robotics going to educating the general population; however this point was quickly shut down by the aspect of that idea being very socialist.

The focus then shifted to public opinion of robotics and jobs. Will people be comfortable with robots performing jobs such as making their food? Currently, much of the public mentality of robots is humanoid machines with red eyes, due to popular media and the like. Most would likely not be comfortable with robots taking over driving cars, however

robots are already very prominent in this field (anti-lock brakes, and stability control). The key that currently there is no real true knowledge among the general population of what a robot is by definition. However, the point was brought up that this upcoming generation is extremely comfortable always being around computers and automated systems, and what seems weird to this current generation, might not be so strange to the next.

The aspect of blame then made its way into the debate. With increased automation in driving and other activities, will humans start to blame their own errors on the robots? Should there be a knowledge cap on certain types of robots to prevent humans from blaming their own mistakes on the automation?

MEDICAL ROBOTIC ETHICS

With the current knowledge of the discussion group reaching its limits on the topic of industrial robotics and jobs, the topic of medical robots was the next to be discussed. Key issues brought up were about benefits, assessing risks, and responsibility. Firstly, it was established that given our current knowledge, it is not clear whether tele-operated surgery is better than human surgery overall. It is clear however, robots can do extraordinary things that humans will never be able to do, such as operation on the surface of a heart while it is still beating. The robot is able to follow the beat of the heart; something a human surgeon could never imaging doing.

A key point was brought up on assessing and defining acceptable risk, compared to human surgeons. It is important to have a defined degree of success that makes the use of a robot more beneficial than a human performing surgery without automated assistance. Currently human judgment is still needed in surgery and no robots perform surgery fully autonomously, but that is possible in the future. So then who is responsible for the mistake of a surgery done with robotics? Is it the company who made the device, or is it the surgeon operating the device?

DIFFERENCES BETWEEN HUMANS AND ROBOTS

In the next session we discussed what makes a person a person and a robot a robot and what is going to happen in the years to come. What is the difference between a person and a robot? An example that was mentioned was a person goes through months and months of training and then given a judgment test, which is common filtering to put together feedbacks and then choose the best choice by judgment. Can a robot be programmed to have judgment?

Will robots one day turn into humans? If they do what will be the difference between a human and a robot? Will we be able to determine who's who? There is a difference between people and humans today, feelings. Can guilt be a good thing for a robot to feel? Guilt limits its access and holds back a robot from acting in certain situations. This is like humans they feel guilty and will not complete a task, whether it is wrong or right. They might also complete a task out of anger, we can really never know how one will feel.

We as humans have intelligence because we have the ability to become motivated on things we want. As a human we can show emotions whether we are happy or sad, a robot can't really express an emotion it just does as it's told. We can never tell if a human or a robot is happy, for all we know a human could seem happy but could not be happy inside, the same with a robot. We should judge from what we see on the outside. Should we though?

An example that was given was on the television show, House, where a woman was diagnosed being psychotic because she could manifest fer feelings and then master them. This sounds like what a robot could do manifest its feelings. Another example that was given was how when people started to get a fast lane pass they then knew they would not have to interact with anyone, which showed this situation to be productive because it would take less time.

In the next section we briefly examined the human psychology when interacting with robots. A big difference between humans and a robot are that a human is naturally

produced and a robot is programmed. We can argue this point that a human is programmed when it's told by its parents what is right and what is wrong.

Another example is what if our children were interacting with robots more than humans, is this going to limit how much a child will learn? Will they have social problems when they attend school? A lot of couples prior to having kids usually end up getting a dog, to see if they can first handle the responsibility of an animal before a child. We know a dog is not a human but could a dog be compared to a robot? Yes a dog cannot speak but a dog can show emotion by wagging its tail and running to its owner.

Finally a great point was made with a relationship that a mother shares with its child. A baby can sense and knows its parents by voice and the way they are held and by the noises. Do we really believe a robot can provide the same nurture as a mother? Can a robot soothe a child? Where can we draw the limits to where a robot can take care of a child?

CONCLUSION

In conclusion, the debate session was definitely a success. Many opinions were brought to the table, and the discussion was constantly active and engaging. The data collected from the debate session will be very valuable in assisting future research. Many broad and specific topics were covered and explored to the fullest knowledge of those taking part. Among the debaters were college students, professors, professionals in industry and the corporate world, and other valuable voices. This debate is proof that group discussion is a solid way to have organized thoughts and views laid out in a manner that is efficient and useful.

Appendix M: WPI Media Advisory



100 Institute Road
Worcester, MA 01609
www.wpi.edu

INVITATION FOR COVERAGE/PHOTO OPP

WPI to Host April 10 Symposium on the Ethical Issues Surrounding Robotics

RoboEthics Will Kick Off WPI's Observance of National Robotics Week

What: Robots have long been used to do dull, dangerous, and dirty jobs. But as they become more sophisticated and able to make decisions on their own, robots are being considered for new roles in society, such as taking care of children and the elderly, protecting our homes, or even fighting wars. These new roles raise issues and concerns that engineers have never had to deal with, and call for new professional codes of ethics. To jumpstart discussion of these important issues, Worcester Polytechnic Institute, the only university in the nation to offer undergraduate and graduate programs in robotics engineering, will present RoboEthics, a daylong symposium on the ethics surrounding the social use of robots. The symposium will kick off WPI's observance of National Robotics Week (April 10-18).

Who: The symposium will feature presentations by industry experts Noel Sharkey, professor of artificial intelligence, robotics, and public engagement at the University of Sheffield in the United Kingdom, and Ronald Arkin, Regents' Professor and director of the Mobile Robot Laboratory at Georgia Institute of Technology and associate dean for research in the institute's College of Computing. A team of WPI juniors (**Brandon Ingram**, a mechanical engineering major; **Daniel Jones**, an electrical and computer engineering major; **Andrew Lewis**, a robotics engineering major; and **Matthew Richards**, a double major in robotics engineering and Interactive Media and Game Development) will present a proposed code of ethics for robotics engineers. There will also be two open debates on ethical issues surrounding the use of robotics in various applications, and students will be able to network with industry professionals.

The symposium is the brainchild of WPI students **Sabrina Varanelli**, a senior double-majoring in robotics engineering and mechanical engineering, of Sacramento, Calif.; **Jola Myrta**, a senior electrical and computer engineering major from Worcester, Mass.; **Andrew Haggerty**, a junior robotics engineering major from Millis, Mass.; and **Alex Scott**, a junior robotics engineering major from Aiken, S.C. They developed the event as part of a research-driven project required for graduation from WPI, the Interactive Qualifying Project (IQP). The IQP applies science and technology to addresses an important societal need or issue.

When: **April 10, 2010, 8:15 a.m. to 4:45 p.m.; view the agenda here.**

Where: **WPI,** Campus Center Odeum, 100 Institute Road, Worcester, Mass.

About Robotics at Worcester Polytechnic Institute

WPI has offered the nation's only bachelor's degree program in robotics engineering since 2007; a master's program was added in 2009 and a PhD program will begin in the fall. Along with a host of WPI-sponsored robotics competitions geared toward children ages 9-18, the degree programs are designed to prepare a new generation of engineers with the skills and imagination to develop intelligent machines that go beyond today's reality. Last fall, WPI hosted the Robotics Innovation Competition and Conference, which challenged college students to engineer

– more –

innovative robotics solutions to real-world problems. In March 2010, WPI was one of 43 locations around the world to host a regional FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition. At the WPI FIRST Regional, approximately 800 high school students from across the Northeast competed with their original robotic creations. BattleCry@WPI, one of the most popular national off-season FIRST Robotics tournaments for high school teams, will be held May 7-8 at WPI.

About Worcester Polytechnic Institute

Founded in 1865 in Worcester, Mass., WPI was one of the nation's first engineering and technology universities. WPI's 14 academic departments offer more than 50 undergraduate and graduate degree programs in science, engineering, technology, management, the social sciences, and the humanities and arts, leading to bachelor's, master's and PhD degrees. WPI's world-class faculty work with students in a number of cutting-edge research areas, leading to breakthroughs and innovations in such fields as biotechnology, fuel cells, and information security, materials processing, and nanotechnology. Students also have the opportunity to make a difference to communities and organizations around the world through the university's innovative Global Perspective Program. There are 26 WPI project centers throughout North America and Central America, Africa, Australia, Asia, and Europe.

###

Contact: Lorraine U. Martinelle, public relations specialist, Worcester Polytechnic Institute, 508-831-6425, lurbans@wpi.edu

Appendix N: Event Photos

Media Impression
Whitbeck1 ethics as...
HeaterAsse...
Panorama Maker 4
Cincinnati photos
UAVs 2010
Andrews Thesis
Shrivenham

requirement of self-preservation.
(fired upon or clear hostile intent), not simply
display of weapon. Tactics can be used to determine hostile intent
without premature use of lethal force (e.g., close approach, inspection).
For POWs, the system has no lingering anger after surrender, reprisals not possible.
There is never intent to target a noncombatant.
Proportionality may be more effectively determined given the absence of a strong
requirement for self-preservation, reducing a need for overwhelming force.
lethality, triggers an ethical evaluation.
"first, do no harm", which indicates that in the absence of
the system is forbidden from acting in a lethal manner.


NATIONAL
Robotics WEEK
2010
Ethics
SYMPOSIUM



NATIONAL
Robotics
SYMPOSIUM

Appendix O: Event Planning Resources

If you are interested in acquiring the full set of event planning materials for purposes of hosting another WPI RoboEthics Symposium, or another event of this type, please email Professor Taskin Padir at tpadir@wpi.edu